TF 1066B/6

TF 1066B/6

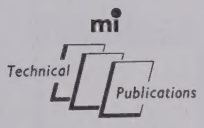
F.M.
Signal Generator

INSTRUCTION MANUAL

MARCONI INSTRUMENTS

Instruction Manual
No. EB 1066B/6
for

F.M. Signal Generator
TF 1066B/6



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MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

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Chapter 1

General information

1.1 INTRODUCTION

The TF 1066B/6 and TF 1066B/6R Signal Generators give c.w., f.m. and a.m. outputs and are intended for making standard measurements and tests on apparatus operating in the v.h.f. and u.h.f. bands. Apart from the normal applications for f.m. receivers, they are particularly suitable for testing multi-channel telemetry equipment requiring a signal source which provides high modulating frequencies and wide deviations with low distortion.

A frequency coverage of 10 Mc/s to 470 Mc/s is provided in five ranges. The clear hand-calibrated tuning scale permits precise frequency setting but, for greater accuracy, a crystal calibrator is incorporated with marker pips available at 1 Mc/s intervals.

Calibrated incremental frequency shifts may be made; either in preset steps or by using the continuously variable control. In each case the amount of shift is indicated by a meter.

F.M. deviations up to 400 kc/s (depending on the carrier range) can be obtained. Two internal modulation frequencies may be selected and the wide frequency response of the modulator permits the use of high frequency external modulating sources. Either internal or external amplitude modulation can be produced to a depth of at least 40%. Accurate monitoring facilities are provided for each type of modulation.

The r.f. output level of the signal generator is controlled by a constant impedance piston-attenuator. The attenuator dial is direct reading in terms of source e.m.f. or voltage developed across a 50 Ω load.

There are two versions of this signal generator; TF 1066B/6, intended for bench mounting and TF 1066B/6R, suitable for mounting in a 19 inch rack.

Fig. 1.1 F.M. Signal Generator TF 1066B/6

1.2 DATA SUMMARY

Frequency

Range:	10 to 470 Mc/s in five bands: 10 to 22 Mc/s, 22 to 50 Mc/s, 50 to 115 Mc/s, 115 to 270 Mc/s, 270 to 470 Mc/s.
Calibration accuracy:	±1%.
Crystal calibrator:	Provides check points every 1 Mc/s with markers every 10 Mc/s. Accuracy ±0.02% at each check point.
Fine tuning:	Uncalibrated control provides cover of approximately 25 kc/s to over 100 kc/s, total depending on carrier frequency.
Frequency stability:	Shift is not greater than 0.015% in a 10 minute period after 1 hour warm-up.
Attenuator reaction:	Negligible below 50 mV; not greater than 0.1% above.
Incremental frequency control:	Carrier shift is variable from -100 kc/s to +100 kc/s by continuous and stepped control. The stepped control has three negative and three positive positions, each with independent preset adjustments, and one zero-shift position. Shift is monitored by meter with two ranges, -20 to +20 kc/s and -100 to +100 kc/s.
Incremental accuracy:	±15% of full-scale at all carrier frequencies. Above 115 Mc/s, the 15% accuracy applies after use of the correction chart supplied. Direct accuracy without chart above 115 Mc/s is ±25% of full-scale.
Spurious signals:	There are no sub-harmonics of the carrier frequency.

R.F. output

Level:	The source e.m.f. is continuously variable from 0.2 μV to 200 mV. The attenuator dial shows the source e.m.f. both directly and in decibels relative to 1 μV. The dial cursor can be positioned to indicate voltage across a 50 Ω load instead of source e.m.f.
Output accuracy:	Overall, ±2 dB.
Source impedance:	50 Ω; v.s.w.r. not greater than 1.25 using the 20 dB pad TM 4919, or 1.6 using the 6 dB pad TM 4919/1.
Stray radiation:	Negligible; permits full use of lowest output.

Frequency modulation

Internal: Modulation frequencies: 1 and 5 kc/s. Deviation variable to 100 kc/s maximum on ranges A and B, 400 kc/s on ranges C and D, and 300 kc/s on range E. Deviation indicated on meter with three ranges: 0 to 20 kc/s, 0 to 100 kc/s and 0 to 400 kc/s.

External: Modulation frequency range: 30 c/s to 100 kc/s. Deviation as for INTERNAL. Input requirements: 25 V across 5 kΩ or more for maximum deviation.

Deviation accuracy: Deviation ranges 0 to 20 kc/s and 0 to 100 kc/s: ±10% of full-scale at all carrier frequencies. Above 115 Mc/s the 10% accuracy applies after use of the correction chart supplied. Direct accuracy without chart above 115 Mc/s is ±20% of full-scale.

Deviation range 0 to 400 kc/s: ±15% of full-scale at all carrier frequencies above 50 Mc/s. Above 115 Mc/s the 15% accuracy applies after use of the correction chart supplied. Direct accuracy without chart above 115 Mc/s is ±20% of full-scale.

Accuracy over external modulation frequency range is within 12% of accuracy at 1 kc/s.

Modulation distortion: Distortion introduced by the modulator is not greater than 10% at the maximum deviation quoted above. Between 215 and 265 Mc/s distortion is not greater than 5% at maximum deviation for modulation frequencies 1 kc/s and above.

A.M. on f.m.: Typically, less than 5% modulation depth at maximum deviation.

Residual f.m.: The f.m. due to hum and noise is less than 100 c/s deviation.

Amplitude modulation

Internal: Modulation frequencies: 1 and 5 kc/s.
Modulation depth variable up to at least 40% and indicated on a meter scaled 0 to 50%.

External: Modulation frequency range: 30 c/s to 15 kc/s. Modulation depth as for INTERNAL. Input requirements: 12 V across 270 kΩ for 50%.

Modulation depth accuracy: ±10% modulation.

F.M. on a.m.: For 30% a.m varies typically from 15 kc/s at 10 Mc/s to 60 kc/s at 100 Mc/s.

Residual a.m. The a.m. due to hum and noise is better than 50 dB below 30% modulation.

Power supply

200 to 250 and 100 to 130 V, 40 to 60 c/s, 90 W. Fuses in mains, h.t. and l.t. circuits.

Dimensions and weight

(in case for bench use)

Height	*Width*	*Depth*	*Weight*
16 in (40.6 cm)	20 3/4 in (52.7 cm)	11 in (27.9 cm)	63 lb (28.6 kg)

1.3 ACCESSORIES

Accessories supplied

(A) 50 Ω coaxial, type N, plug for R. F. OUT socket.

(B) Jack plug, Igranic type P.40, for PHONES socket.

(C) Correction chart for the MODULATION and INCREMENTAL FREQUENCY MONITOR.

Accessories available

① OUTPUT LEAD, type TM 4824
50 Ω. Type N plug - type N plug, 3 ft long.

② 20 dB PAD type TM 4919
50 Ω. Type N plug - type N socket.

③ 6 dB PAD type TM 4919/1
50 Ω. Type N plug - type N socket.

④ MATCHING PAD type TM 4918
50 Ω to 75 Ω. Type N socket - Belling Lee L734/P plug.

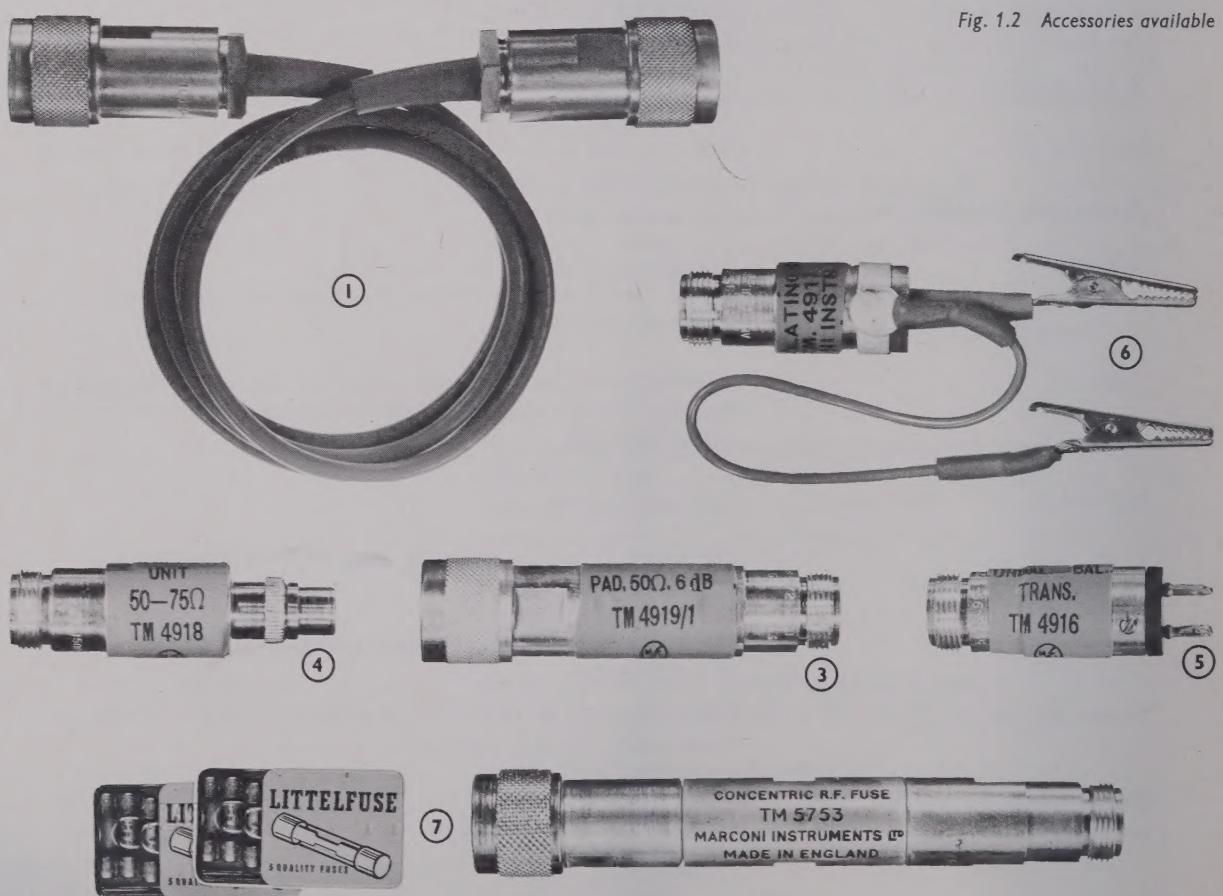
⑤ MATCHING PAD type TM 4916
50 Ω to 300 Ω balanced, type N socket - solder tags.

⑥ D. C. ISOLATING UNIT type TM 4917
Type N socket - crocodile clips.

⑦ COAXIAL FUSE type TM 5753
To prevent damage to the signal generator in the event of accidental application of r. f. or h. t. power to the circuit under test.

Overload protection:	Burns out at 0.4 W.
Insertion loss:	Nominally 0.5 dB.
V. S. W. R.:	1.35 or less when terminated with a matched 50 Ω load. 1.6 or less when terminated with TF 1066B/6 attenuator via 20 dB pad TM 4919.
Connector:	Type N.
Fuse:	1/16 A Littelfuse Cat. No. 361.062. 10 spares are supplied.

Fig. 1.2 Accessories available



Chapter 2

Operation

2.1 PREPARATION FOR USE

Take off the transparent cover if one is supplied with the instrument. If the cover is not completely removed when the instrument is operated, overheating may occur.

Bench or rack mounting

The TF 1066B/6 is supplied in a case and is intended for bench mounting. The TF 1066B/6R is fitted with a dust cover and is suitable for mounting in a 19 inch rack.

Before putting the instrument into use, the domed cover on the right-hand side of the case must be reversed so that it protrudes from the case. To do this, extract the three screws holding the cover, lift it out and turn it over, and then refit the screws. When fitting the instrument to a rack or upon removal or refitting of the dust cover, ensure that the attenuator is turned to the maximum output position (fully retracted).

Either version should be so positioned that the ventilating holes, at the rear and underneath, are not obstructed.

When mounting the signal generator the usual precautions against microphonic modulation should be taken. Although every effort has been made, in the design, to minimize this type of effect, it is not possible under adverse environmental conditions, to eliminate it entirely. Thus for applications where a particularly low level of spurious modulation is required, it is an advantage to stand the signal generator on a sponge-rubber or felt mat and to reduce the a.f. output of any receiver to a minimum.

Supply voltage

Before connecting the instrument to the mains supply make sure that the mains adjustment tapping panel is set correctly for the local supply voltage. Access to the panel is obtained by opening the left-hand hinged door at the rear of the case of the TF 1066B/6 or by removing the dust cover of the TF 1066B/6R. The panel consists of four two-pin plugs which make contact with the mains transformer connections through a reversible masking plate.

The instrument is normally dispatched with its mains input adjusted for 240 V operation. To change the mains tappings from one within the 200 to 250 V range to one within the 100 to 130 V range, or vice versa, it is necessary to reverse the masking plate. The arrangements of the two-pin plugs corresponding to all the possible mains input voltages are shown in the diagram SUPPLY VOLTAGE PLUG SETTINGS, Fig. 2.1.

Masking plate and links must be positioned according to supply voltage, as shown:

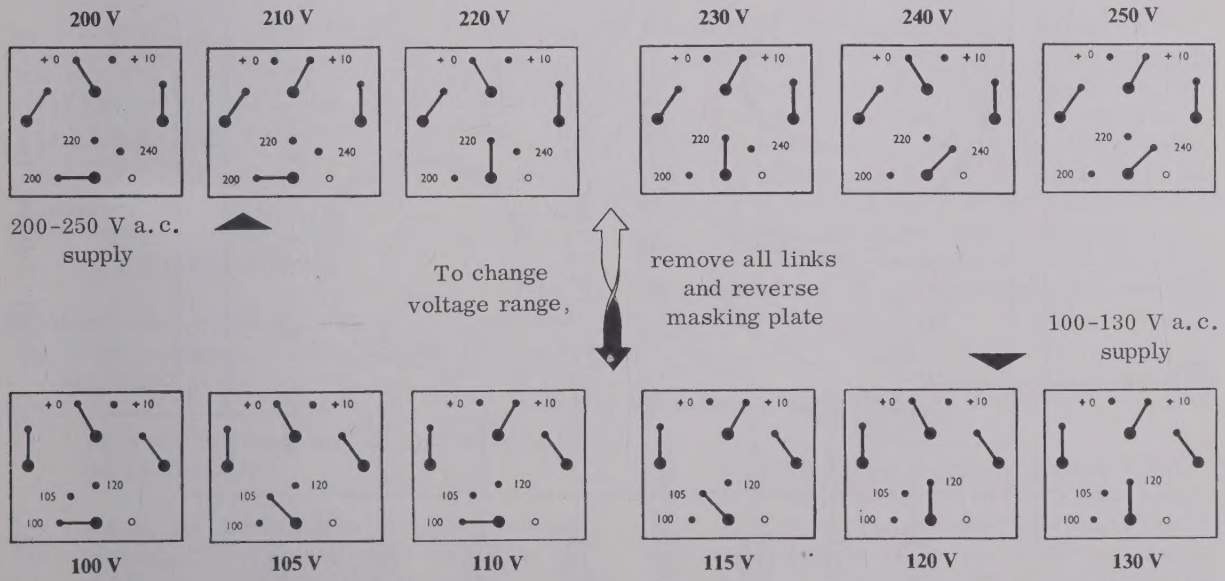


Fig. 2.1 Supply voltage panel

Meter zeroing

Adjust the set zero screws at the top of the CARRIER LEVEL and the MODULATION and INCREMENTAL FREQUENCY monitors to bring each pointer to the left-hand zero mark.

2.2 CONTROLS

① MAIN TUNING DIAL
1A CURSOR
1B CURSOR LOCKING SCREW

② COARSE TUNING CONTROL

③ FINE TUNING CONTROL. For making small uncalibrated frequency adjustments.

④ RANGE CONTROL. To change from one band to another, rotate the control through one-and-a-fifth turns per band until it locates positively, with the knob pointing to the required frequency band.

⑤ SET CARRIER CONTROL. For bringing the carrier to a predetermined level, indicated by ⑥.

⑥ CARRIER LEVEL MONITOR.

⑦ INCREMENTAL FREQUENCY STEPS CONTROL. Shifts the carrier frequency in six preset steps to a maximum of 100 kc/s in either direction.

⑧ INCREMENTAL FREQUENCY VARIABLE CONTROL. Provides continuously variable shift of carrier frequency up to a maximum of 100 kc/s in either direction.

⑨ MODULATION SELECTOR.

⑩ F. M. RANGE SWITCH. Sets the deviation range.

⑪ MODULATING FREQUENCY SWITCH. Operates on a. m. and f. m.

⑫ SET MODULATION CONTROL. Adjusts f. m. deviation or a. m. depth.

⑬ MODULATION AND INCREMENTAL FREQUENCY MONITOR. Indicates f. m.

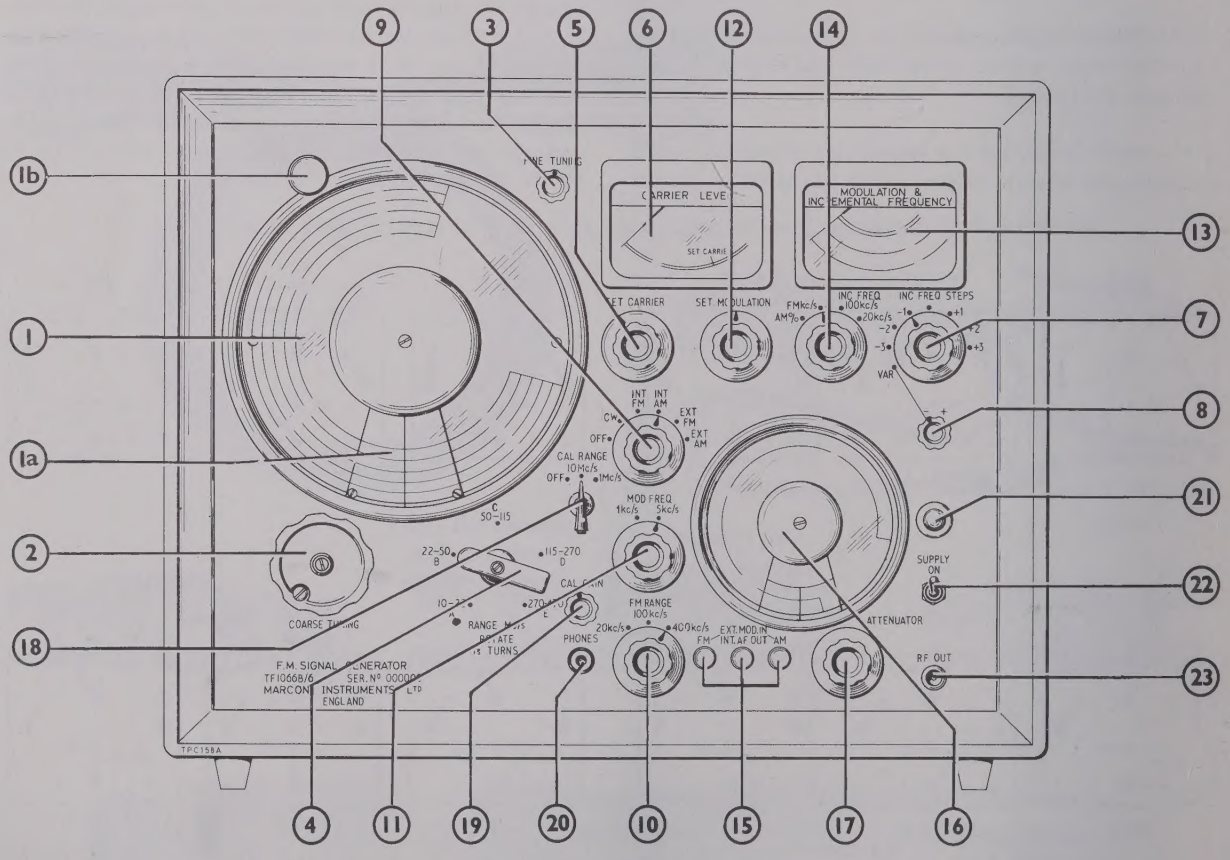


Fig. 2.2

deviation, a.m. depth, and stepped or variable incremental frequency shift.

⑭ MONITOR SELECTION SWITCH. Selects the function required for monitor ⑬ .

⑮ EXTERNAL MODULATION TERMINALS. Input terminals for external modulating sources or for external incremental frequency shift voltages. They act also as output terminals for the internal a.f. oscillator.

⑯ ATTENUATOR DIAL. Direct reading for source e.m.f. or p.d. across a 50 Ω load, in terms of voltage and dB referred to 1 μV.

⑰ ATTENUATOR CONTROL.

⑱ CRYSTAL CALIBRATOR RANGE SWITCH. Selects 1 Mc/s or 10 Mc/s markers.

⑲ CRYSTAL CALIBRATOR GAIN CONTROL.

⑳ PHONES JACK. For monitoring the calibrator check points.

㉑ PILOT LAMP.

㉒ SUPPLY SWITCH.

㉓ R.F. OUTPUT SOCKET. Accepts type N plug.

2.3 QUICK OPERATIONAL CHECK

The following sequence of operations will enable you to get the feel of the controls and to check that the r.f. oscillator, modulation circuits, monitor and crystal calibrator are working.

Tuning

㉒ Switch to SUPPLY ON.

⑦ ③ Set the INC. FREQ. switch to its central 'zero' position, and the FINE TUNING control to mid-travel.

④ Turn the frequency RANGE switch to band B (22 to 50 Mc/s).

② ① ⑨ Adjust the COARSE TUNING control for an indication of 30 Mc/s against the cursor on the tuning dial and set the modulation selector to C.W.

⑥ Bring the pointer of the CARRIER LEVEL meter to the SET CARRIER mark by adjusting the SET CARRIER control, and note that the control is within, say, the middle third of its travel.

Crystal calibrator

⑱ ⑳ ② Turn the crystal CALibrator RANGE switch to 10 Mc/s, plug in a pair of high resistance head phones into the PHONES socket and slightly adjust the COARSE TUNING control until a beat note is heard.

② ⑱ Retune to 32 Mc/s, using the COARSE TUNING control and turn the CALibrator RANGE switch to 1 Mc/s. Again make slight adjustments to the COARSE TUNING control until a beat note is heard.

Incremental frequency

⑭ ⑦ Set the monitor selector to INC. FREQ. 20 kc/s and the INCREMENTAL FREQUENCY STEPS control to VAR.

⑧ ⑬ Advance the continuously VARIABLE INCREMENTAL FREQUENCY control and observe that the beat note changes pitch and disappears. There should now be a deflection on the MODULATION AND INCREMENTAL FREQUENCY monitor, indicating the frequency shift produced.

Frequency modulation

⑦ ⑱ ⑨ ⑭ ⑩ ⑫ ⑬ Return the INCREMENTAL FREQUENCY STEPS control to its centre zero position and turn the crystal calibrator off using the CAL RANGE switch. Set the modulation selector switch to INT. F.M., the monitor selector switch to F.M. kc/s and the F.M. RANGE switch to 100 kc/s. Advance the SET MODULATION control and observe that full scale deflection of the MODULATION AND INCREMENTAL FREQUENCY monitor can be obtained.

Amplitude modulation

⑨ ⑭ ⑫ ⑬ Set the modulation selector switch to INT. A.M. and the monitor selector switch to A.M.%. Adjust the SET MODULATION control for an indication of 40% modulation depth on the MODULATION and INCREMENTAL FREQUENCY monitor.

2.4 C.W. OPERATION

Tuning

(22) Switch to SUPPLY ON and allow time to warm up.

(4) Select the required frequency band by means of the RANGE control. For best frequency stability allow a stabilizing period of 10 minutes after range changing.

(7) Turn the INC. FREQ. STEPS control to the zero position.

(2) Adjust the COARSE TUNING control until the approximate frequency required appears (1) against the cursor on the tuning dial.

Final adjustment, to bring the frequency precisely to a particular point on the characteristic of a tuned system under test, can be (3) made with the FINE TUNING control.

Calibration

(18) For maximum accuracy switch on the crystal calibrator and select the frequency interval at which markers are required (10 Mc/s or (20) 1 Mc/s. Plug headphones into the PHONES (2) jack. Readjust the COARSE TUNING control for zero beat at the nearest crystal marker point.

(1a) Set the cursor into coincidence with the selected marker frequency by slackening (1b) the locking knob and rotating the whole frequency dial cover and cursor. Re-tighten the locking knob.

At most frequencies additional markers of much lower amplitude may be heard. These correspond to 0.5 Mc/s intervals and, if required, they may be used as extra calibration points. Take care, however, not to confuse these with 0.33 Mc/s markers which can usually be heard at 13.33, 16.66 and 18.33 Mc/s on range A or 23.33, 26.66 and 33.33 Mc/s on range B. If these cause difficulty, first align the cursor using the 10 Mc/s marker nearest to the desired frequency, then retune using the 1 Mc/s markers.

Output level

(9) Turn the modulation selector to C.W. and (5) adjust the SET CARRIER control so that the (6) pointer of the CARRIER LEVEL meter coincides with the SET CARRIER mark.

(17) Adjust the ATTENUATOR control for the required output.

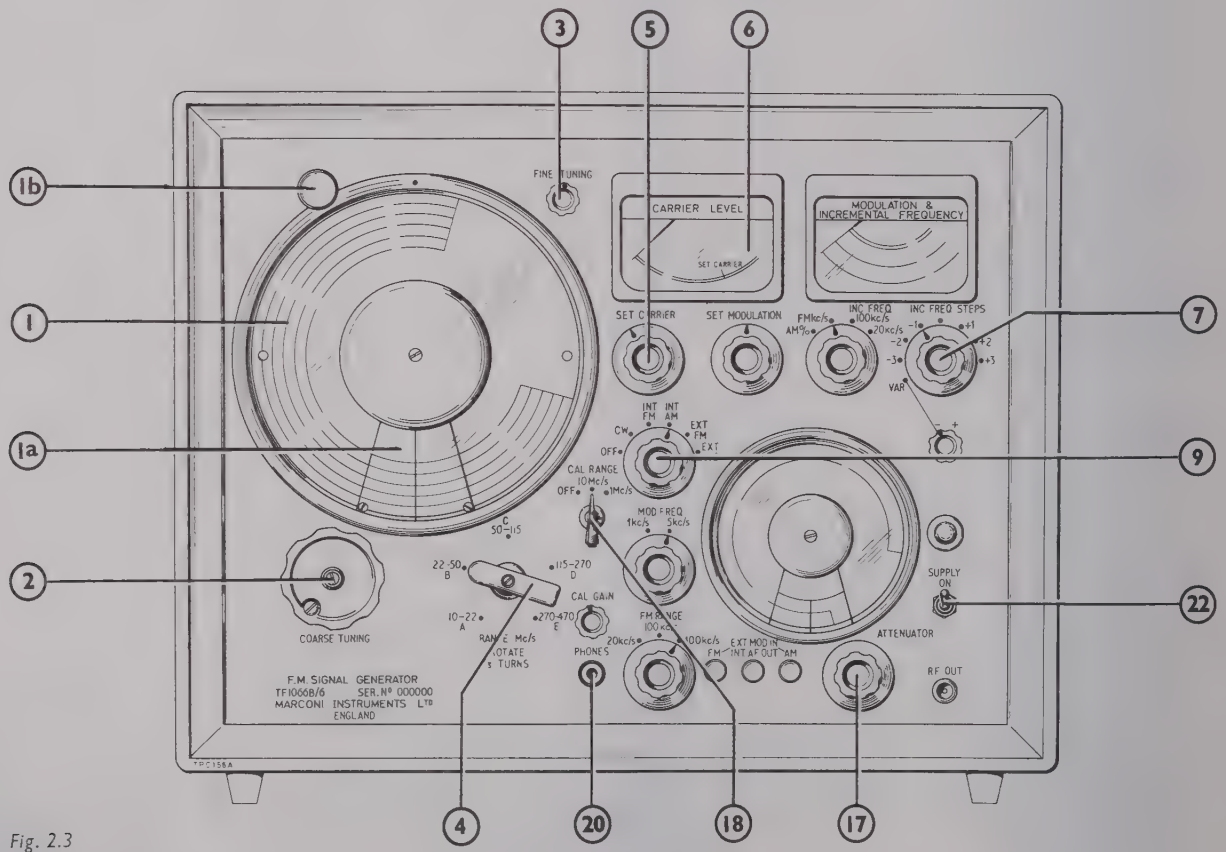


Fig. 2.3

2.5 INCREMENTAL TUNING

(a) Continuously variable

Turn the INC. FREQ. STEPS control to VAR and check that the monitor selector switch is set to the appropriate sensitivity INC. FREQ. position. Adjust the continuously variable incremental frequency control until the required frequency shift is indicated on the corresponding scale of the MODULATION AND INCREMENTAL FREQUENCY monitor.

For maximum accuracy above 115 Mc/s carrier frequency, apply the correction given by the curves on the CORRECTION CHART for DEVIATION AND INCREMENTAL FREQUENCY MONITOR.

(b) Stepped

The incremental frequency steps are set, in the factory, to give zero shift. To set up your own choice of steps, see Section 4.3.

When the steps have been set up the INC. FREQ. STEPS controls may be used to give positive or negative preset shifts of carrier.

Stepped increments are indicated by the MODULATION AND INCREMENTAL FREQUENCY monitor with the same accuracy as for continuously variable control. For greater accuracy the steps can be set up against a standard frequency r.f. source.

NOTE: If an external circuit, connected between the EXT. MOD. F.M. and earth terminals, offers a d.c. path, the potential divider circuit controlling the frequency shift will be shunted and the accuracy of the incremental steps will be affected.

(c) External

Incremental frequency shifts can be produced by the application of an external voltage between the EXT. MOD. F.M. and earth terminals. This may be useful for the production of stepped frequency shifts additional to those already set up in the signal generator.

Set the INC. FREQ. switch to VAR, the continuously variable control to mid-travel and connect a suitable voltage source between the EXT. MOD. F.M. and earth terminals.

The voltage required for a frequency shift of 100 kc/s is approximately 60 V. If frequency shifts both above and below the centre frequency are desired, provision must be made for both positive and negative polarity voltages.

The frequency shift produced is indicated on the appropriate scale of the MODULATION AND INCREMENTAL FREQUENCY monitor.

To preserve the accuracy of the internal incremental frequency steps, remove the external d.c. shift circuit from the EXT. MOD. F.M. terminals when it is not in use.

(d) Modulator hysteresis

When making incremental frequency shifts by any of the methods described above, you may find some inconsistency of results due to the inherent hysteresis of the ferrite modulator.

The effects of this hysteresis are only of significance when the direction of shift is reversed. If the shift is increased to a particular value from the true (neutralized) zero and then further increased, the problem does not arise.

Errors due to hysteresis will generally be small - of the order of 5% of the shift - and can be eliminated by 'wiping' or neutralizing the magnetic circuit of the modulator before making a reversal of frequency shift. As a point of good practice, neutralization should also be carried out before commencing any measurements involving use of the incremental frequency controls.

To neutralize the modulator, first set the incremental shift to zero and apply f.m. to the carrier; then, having set the deviation initially to maximum, reduce it slowly to zero. With the modulator now neutralized it may be advisable to check that the signal generator is still correctly tuned to the centre frequency of the equipment under test.

The following example shows the points, in a typical sequence of incremental shifts, at which it is desirable to neutralize the modulator.

Example: In a receiver response investigation, it is required to shift the carrier +50, +75, +100 kc/s; then to drop back in frequency and re-check results at +50 kc/s. Do this by:

(1) neutralizing at zero shift;
(2) setting to +50 kc/s;
(3) setting to +75 kc/s;
(4) setting to +100 kc/s;
(5) returning to zero and neutralizing again;
(6) setting to +50 kc/s.

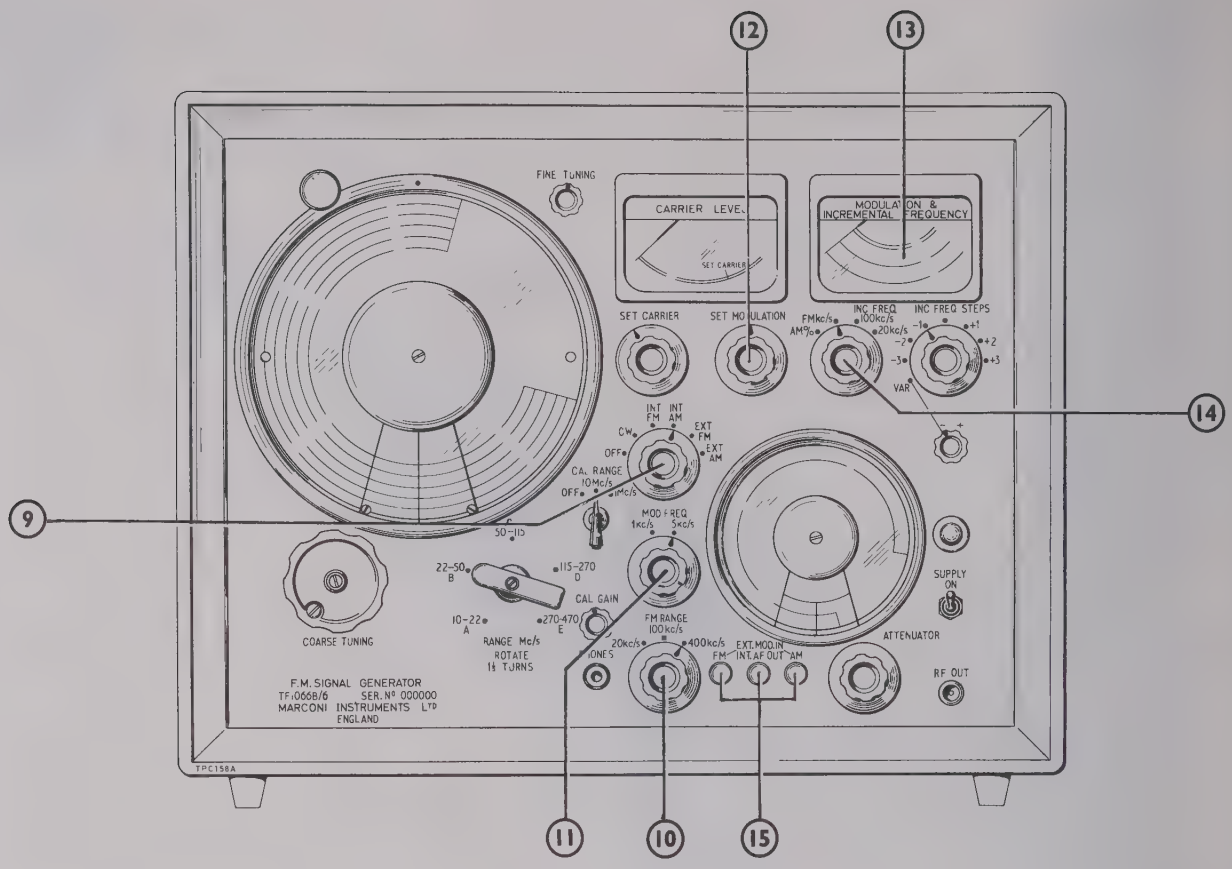


Fig. 2.4

2.6 F.M. OPERATION

The accuracy of the deviation indication and the waveform of the demodulated signal may tend to deteriorate slightly when carrier shift is applied by means of the incremental frequency controls. It is generally advisable, therefore, to keep the INC. FREQ. STEPS control in its zero position when using frequency modulation.

Internal

Switch on, tune, and set output as for C. W.

⑨ Turn the modulator selector switch to INT.
⑭ F. M. and the monitor selector switch to F. M.

⑪ Select the modulating frequency required.

⑩ Turn the F. M. RANGE switch to the deviation
⑫ range required and adjust the SET MODU-
LATION control until the MODULATION AND
⑬ INCREMENTAL FREQUENCY monitor indicates the required deviation.

NOTE: The maximum deviation range to 400 kc/s is only available on the frequency ranges C and D; see DATA SUMMARY Section 1.2.

To achieve maximum accuracy of deviation settings, at carrier frequencies above 115 Mc/s, a correction to the monitor reading should be made. Curves showing the corrections are included on the CORRECTION CHARTS FOR DEVIATION AND INCREMENTAL FREQUENCY MONITOR, which are normally stowed in the left-hand handle recess.

A.F. output

When the modulation selector is set to INT. F. M. the internal modulation signal is available at the EXT. MOD. F. M. and earth terminals. This output may be used as a convenient synchronizing signal when the signal generator is used in conjunction with a cathode-ray oscilloscope. At a deviation of 100 kc/s the output level is of the order of 20 V r. m. s. Do not leave a d. c. path between the terminals; see final paragraph of Section 2.5 (b).

External

Switch on, tune and set output as for C. W.

⑨ Turn the modulation selector switch to EXT.
⑭ F.M. and the monitor selector switch to F.M.

⑩ Set the F.M. RANGE switch to the deviation range required.

For external modulation, this does not affect the sensitivity of the modulation circuits, but selects the appropriate monitor sensitivity range.

⑮ Connect the external a.f. signal source to the EXT. MOD. F.M. and earth terminals, and adjust the input level to give the required deviation as indicated on the MODULATION
⑬ AND INCREMENTAL FREQUENCY monitor. The input level required for full deviation is approximately 25 V, the input impedance being 5 kΩ. Do not leave a d.c. path between the terminals; see final paragraph of Section 2.5 (b). At carrier frequencies above 115 Mc/s a correction to the monitor reading should be made, in the same manner as for internal modulations.

2.7 A.M. OPERATION

Internal

Switch on, tune and adjust the output as for C.W.

⑨ Set the modulation selector switch to INT. A.M.
⑫ and turn the SET MODULATION control to minimum (fully counter-clockwise).

⑭ Turn the monitor selector switch to A.M.
⑪ Select the modulation frequency required.

⑫ Adjust the SET MODULATION control until
⑬ the MODULATION AND INCREMENTAL FREQUENCY monitor indicates the required percentage modulation. The movement of the SET MODULATION control may cause a change in the deflection of the CARRIER LEVEL monitor; do not readjust the SET CARRIER control to bring the pointer back to the SET CARRIER mark.

A.F. output

When the modulation selector is set to INT. A.M., the internal modulating signal is made available at the EXT. MOD. A.M. and earth terminals. This output may be used as a synchronizing signal when the signal generator is used in conjunction with a cathode-ray oscilloscope. At 40% modulation depth, the output level is of the order of 10 V r.m.s.

External

Switch on, tune and adjust the output as for C.W.

⑨ Set the modulation selector switch to EXT. A.M.

⑭ Turn the monitor selector switch to A.M.

⑮ Connect the external a.f. source to the EXT. MOD. A.M. and earth terminals and adjust the input level until the required modulation depth is indicated on the MODULATION AND
⑬ INCREMENTAL FREQUENCY monitor. If this action causes a change in the deflection of the CARRIER LEVEL monitor, do not readjust the SET CARRIER control to bring the pointer back to the SET CARRIER mark.

2.8 R.F. OUTPUT ARRANGEMENTS

The r.f. output circuit of the signal generator should be regarded as a zero impedance voltage source in series with a resistance of 50 Ω. This is shown in Fig. 2.5 where:

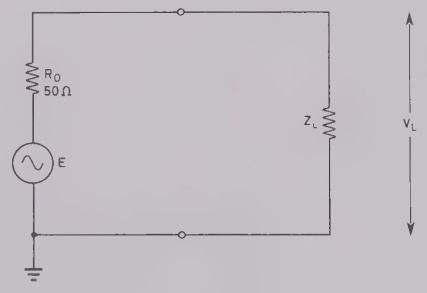


Fig. 2.5 Equivalent output circuit TPA489

E is the indicated source e.m.f.

R_o is the source resistance.

Z_L is the external load impedance.

V_L, the voltage developed across the load is given by

$$V_L = E \frac{Z_L}{R_o + Z_L}$$

or, for purely resistive loads

$$V_L = E \frac{R_L}{R_o + R_L}$$

Table 2.1 shows the conversion factors for obtaining the load voltage from the indicated e.m.f. at different load impedances.

When using a correctly matched, i.e. 50 Ω output lead its output end can be regarded as an extension to the output socket on the generator and wide variations of load impedance do not seriously affect the calculated load voltage obtained from Table 2.1. Standing waves produced by the mismatched load can, for most purposes, be ignored.

For greatest accuracy - if the additional attenuation can be tolerated - use the 20 dB Attenuator Pad type TM 4919 between seriously mismatched loads and the output lead. This ensures that the lead is correctly terminated, and also attenuates any extraneous noise induced in the lead.

Table 2.1

To find load voltage

Load ohms	*Multiply e.m.f. by*	*or subtract dB*
10	0.167	15.5
20	0.286	10.9
30	0.375	8.5
40	0.445	7.0
50	0.50	6.0
60	0.55	5.2
70	0.58	4.7
75	0.60	4.4
80	0.62	4.2
90	0.64	3.8
100	0.67	3.5
120	0.71	3.0
150	0.75	2.5
200	0.80	1.9
300	0.86	1.3
500	0.91	0.8
600	0.92	0.7
800	0.94	0.5
1000	0.95	0.4
2000	0.98	0.2
4000	0.99	0.1

The attenuator dial gives a direct reading of the output level, provided that the carrier level has been correctly set. It has two scales; one calibrated in units of voltage and the other is dB referred to 1 μV.

The cursor carries two hairlines; one vertical and one inclined at an angle corresponding to a 6 dB movement of the dial.

On one side of the cursor the inclined hairline is marked E.M.F. FROM 50 Ω SOURCE and indicates the output level in terms of source e.m.f. The vertical hairline is marked -6 dB and gives the effective source e.m.f. when the output is taken via the 6 dB attenuator (type TM 4919/1).

On the other side of the cursor the vertical hairline is marked E.M.F. INTO 50 Ω LOAD and thus reads the potential developed across a 50 Ω load. The inclined hairline is marked -6 dB and gives the corresponding load voltage when the 6 dB attenuator is used.

To reverse the cursor; extract the centre screw and remove the dial window, spun metal cover and spring at the centre of the dial. The cursor may now be reversed and the window components reassembled.

Matching to high impedance loads

To present a load that is greater than 50 Ω with a signal derived from a matched source, a resistor R_S is added in series with the generator output. The value of R_S is given by the difference between the load and the generator impedances, that is

$$R_s = R_L - R_o$$

The voltage across the load, V_L, is given by

$$V_L = \frac{E}{2}$$

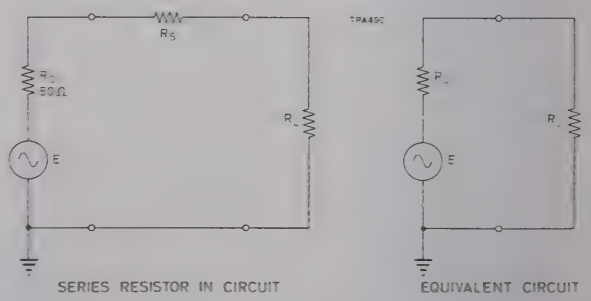


Fig. 2.6 High-impedance matching

For the special case of a 75 Ω load a Matching Pad, type TM 4918, is available as an accessory and consists basically of a 25 Ω resistor with coaxial connectors for insertion in series with the output lead.

Matching to low impedance loads

To present a load that is less than 50 Ω with a signal derived from a matched source, a resistor R_p is added in parallel with the generator output. The value of R_p is given by

$$R_p = \frac{R_o R_L}{R_o - R_L}$$

The effective source e.m.f., is now different and is given by

$$E_1 = E \frac{R_p}{R_o + R_p}$$

and the voltage across the load, V_L, is given by

$$V_L = \frac{E_1}{2}$$

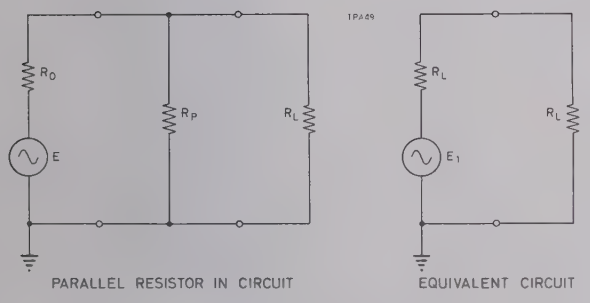


Fig. 2.7 Low-impedance matching

Matching to balanced loads

Equipment whose input circuit is in the form of a balanced winding can be fed from the generator by using two series resistors as shown in Fig. 2.8. This method makes use of the auto-transformer effect of the centre-tapped winding and is not suitable for resistive balanced loads.

The values of R (for use in the centre conductor) and R_2 (for the earth lead) are given by

$$R_1 = \frac{R_L}{2} - 50$$

$$R_2 = \frac{R_L}{2}$$

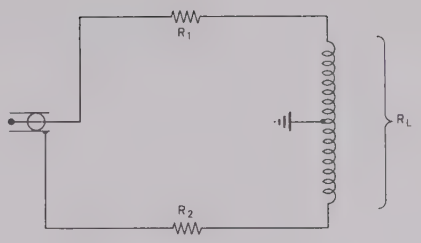


Fig. 2.8 Balanced load matching TPA488

Use of attenuator pads

The matching methods described above cause the output end of the r.f. lead to be mismatched. To avoid the errors in apparent e.m.f. or output impedance which might thus arise at higher frequencies, due to the presence of standing waves, the 20 dB attenuator (type TM 4919) should be inserted at the output end of the r.f. lead. With the attenuator in circuit, variations of load impedance between zero and infinity cause the effective value to depart from the correct value by as little as 1 Ω.

For all applications of the signal generator it is recommended - provided that the reduced output e.m.f. can be tolerated - that the 20 dB attenuator be permanently connected to the output end of the r.f. lead. Apart from the benefits of load isolation described above, the effect of noise picked up in the lead is much reduced. This is of particular advantage when making signal-to-noise ratio tests on receivers at low level inputs.

If, for a particular application, a 20 dB loss is not acceptable, the 6 dB attenuator will give satisfactory results in most instances.

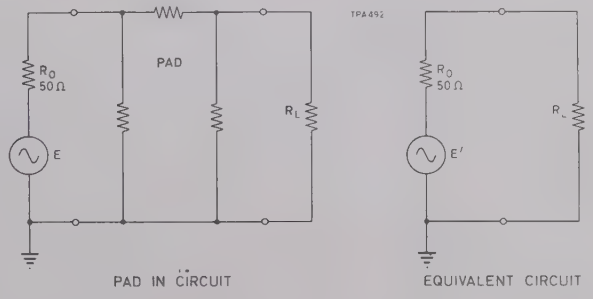


Fig. 2.9 Output circuit using pad

The attenuator pad reduces the effective source e.m.f. by a factor of 10, or 2, depending on whether the 20 dB or the 6 dB attenuator is used. The figures for load voltage obtained from Table 2.1 must, therefore, be reduced by the appropriate factor.

The effective e.m.f. is given by

$$E' = \frac{E}{10} \text{ for the 20 dB attenuator}$$

$$\text{or } E' = \frac{E}{2} \text{ for the 6 dB attenuator}$$

hence the load voltage, V_L, becomes

$$V_L = \frac{E}{10} \cdot \frac{R_L}{R_L + R_o}$$

for the 20 dB attenuator

$$\text{or } V_L = \frac{E}{2} \cdot \frac{R_L}{R_L + R_o}$$

for the 6 dB attenuator

When matching to loads other than 50 Ω, the matching resistor must be inserted on the output side of the attenuator; the expressions given on page 15 then become

(a) 20 dB attenuator

For series matching, $V_L = \frac{E}{20}$

For parallel matching,

$$V_L = \frac{E_1}{20} = \frac{E}{20} \cdot \frac{R_p}{R_p + R_o}$$

(b) 6 dB attenuator

For series matching, $V_L = \frac{E}{4}$

For parallel matching,

$$V_L = \frac{E_1}{4} = \frac{E}{4} \cdot \frac{R_p}{R_p - R_o}$$

Use of dummy aerial and d.c. isolator

To use this dual-purpose unit as a dummy aerial, connect the EMF/10 and E terminals to the receiver under test. The unit then simulates the impedance of a typical aerial for broadcast receivers in the l.f., m.f. and h.f. bands, and provides an output voltage of one-tenth of that indicated by the attenuator dials.

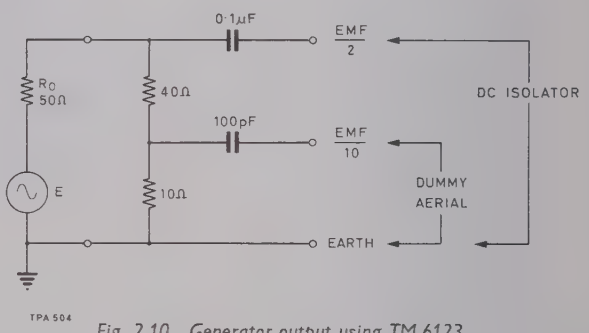


Fig. 2.10 Generator output using TM 6123

To use it as a 350 V d.c. isolator, connect the EMF/2 and E terminals to the equipment under test. This allows the signal generator output to be applied to circuits having a standing d.c. potential up to 350 V. The output voltage is half of that indicated by the attenuator dials.

DECIBEL CONVERSION TABLE

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
1·0	1·0	**0**	1·0	1·0
·9886	·9772	**·1**	1·012	1·023
·9772	·9550	**·2**	1·023	1·047
·9661	·9333	**·3**	1·035	1·072
·9550	·9120	**·4**	1·047	1·096
·9441	·8913	**·5**	1·059	1·122
·9333	·8710	**·6**	1·072	1·148
·9226	·8511	**·7**	1·084	1·175
·9120	·8318	**·8**	1·096	1·202
·9016	·8128	**·9**	1·109	1·230
·8913	·7943	**1·0**	1·122	1·259
·8710	·7586	**1·2**	1·148	1·318
·8511	·7244	**1·4**	1·175	1·380
·8318	·6918	**1·6**	1·202	1·445
·8128	·6607	**1·8**	1·230	1·514
·7943	·6310	**2·0**	1·259	1·585
·7762	·6026	**2·2**	1·288	1·660
·7586	·5754	**2·4**	1·318	1·738
·7413	·5495	**2·6**	1·349	1·820
·7244	·5248	**2·8**	1·380	1·905
·7079	·5012	**3·0**	1·413	1·995
·6683	·4467	**3·5**	1·496	2·239
·6310	·3981	**4·0**	1·585	2·512
·5957	·3548	**4·5**	1·679	2·818
·5623	·3162	**5·0**	1·778	3·162
·5309	·2818	**5·5**	1·884	3·548
·5012	·2512	**6**	1·995	3·981
·4467	·1995	**7**	2·239	5·012
·3981	·1585	**8**	2·512	6·310
·3548	·1259	**9**	2·818	7·943
·3162	·1000	**10**	3·162	10·000
·2818	·07943	**11**	3·548	12·59
·2512	·06310	**12**	3·981	15·85
·2239	·05012	**13**	4·467	19·95
·1995	·03981	**14**	5·012	25·12
·1778	·03162.	**15**	5·623	31·62

DECIBEL CONVERSION TABLE (continued)

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
·1585	·02512	16	6·310	39·81
·1413	·01995	17	7·079	50·12
·1259	·01585	18	7·943	63·10
·1122	·01259	19	8·913	79·43
·1000	·01000	20	10·000	100·00
·07943	$6{\cdot}310 \times 10^{-3}$	22	12·59	158·5
·06310	$3{\cdot}981 \times 10^{-3}$	24	15·85	251·2
·05012	$2{\cdot}512 \times 10^{-3}$	26	19·95	398·1
·03981	$1{\cdot}585 \times 10^{-3}$	28	25·12	631·0
·03162	$1{\cdot}000 \times 10^{-3}$	30	31·62	1,000
·02512	$6{\cdot}310 \times 10^{-4}$	32	39·81	$1{\cdot}585 \times 10^{3}$
·01995	$3{\cdot}981 \times 10^{-4}$	34	50·12	$2{\cdot}512 \times 10^{3}$
·01585	$2{\cdot}512 \times 10^{-4}$	36	63·10	$3{\cdot}981 \times 10^{3}$
·01259	$1{\cdot}585 \times 10^{-4}$	38	79·43	$6{\cdot}310 \times 10^{3}$
·01000	$1{\cdot}000 \times 10^{-4}$	40	100·00	$1{\cdot}000 \times 10^{4}$
$7{\cdot}943 \times 10^{-3}$	$6{\cdot}310 \times 10^{-5}$	42	125·9	$1{\cdot}585 \times 10^{4}$
$6{\cdot}310 \times 10^{-3}$	$3{\cdot}981 \times 10^{-5}$	44	158·5	$2{\cdot}512 \times 10^{4}$
$5{\cdot}012 \times 10^{-3}$	$2{\cdot}512 \times 10^{-5}$	46	199·5	$3{\cdot}981 \times 10^{4}$
$3{\cdot}981 \times 10^{-3}$	$1{\cdot}585 \times 10^{-5}$	48	251·2	$6{\cdot}310 \times 10^{4}$
$3{\cdot}162 \times 10^{-3}$	$1{\cdot}000 \times 10^{-5}$	50	316·2	$1{\cdot}000 \times 10^{5}$
$2{\cdot}512 \times 10^{-3}$	$6{\cdot}310 \times 10^{-6}$	52	398·1	$1{\cdot}585 \times 10^{5}$
$1{\cdot}995 \times 10^{-3}$	$3{\cdot}981 \times 10^{-6}$	54	501·2	$2{\cdot}512 \times 10^{5}$
$1{\cdot}585 \times 10^{-3}$	$2{\cdot}512 \times 10^{-6}$	56	631·0	$3{\cdot}981 \times 10^{5}$
$1{\cdot}259 \times 10^{-3}$	$1{\cdot}585 \times 10^{-6}$	58	794·3	$6{\cdot}310 \times 10^{5}$
$1{\cdot}000 \times 10^{-3}$	$1{\cdot}000 \times 10^{-6}$	60	1,000	$1{\cdot}000 \times 10^{6}$
$5{\cdot}623 \times 10^{-4}$	$3{\cdot}162 \times 10^{-7}$	65	$1{\cdot}778 \times 10^{3}$	$3{\cdot}162 \times 10^{6}$
$3{\cdot}162 \times 10^{-4}$	$1{\cdot}000 \times 10^{-7}$	70	$3{\cdot}162 \times 10^{3}$	$1{\cdot}000 \times 10^{7}$
$1{\cdot}778 \times 10^{-4}$	$3{\cdot}162 \times 10^{-8}$	75	$5{\cdot}623 \times 10^{3}$	$3{\cdot}162 \times 10^{7}$
$1{\cdot}000 \times 10^{-4}$	$1{\cdot}000 \times 10^{-8}$	80	$1{\cdot}000 \times 10^{4}$	$1{\cdot}000 \times 10^{8}$
$5{\cdot}623 \times 10^{-5}$	$3{\cdot}162 \times 10^{-9}$	85	$1{\cdot}778 \times 10^{4}$	$3{\cdot}162 \times 10^{8}$
$3{\cdot}162 \times 10^{-5}$	$1{\cdot}000 \times 10^{-9}$	90	$3{\cdot}162 \times 10^{4}$	$1{\cdot}000 \times 10^{9}$
$1{\cdot}000 \times 10^{-5}$	$1{\cdot}000 \times 10^{-10}$	100	$1{\cdot}000 \times 10^{5}$	$1{\cdot}000 \times 10^{10}$
$3{\cdot}162 \times 10^{-6}$	$1{\cdot}000 \times 10^{-11}$	110	$3{\cdot}162 \times 10^{5}$	$1{\cdot}000 \times 10^{11}$
$1{\cdot}000 \times 10^{-6}$	$1{\cdot}000 \times 10^{-12}$	120	$1{\cdot}000 \times 10^{6}$	$1{\cdot}000 \times 10^{12}$
$3{\cdot}162 \times 10^{-7}$	$1{\cdot}000 \times 10^{-13}$	130	$3{\cdot}162 \times 10^{6}$	$1{\cdot}000 \times 10^{13}$
$1{\cdot}000 \times 10^{-7}$	$1{\cdot}000 \times 10^{-14}$	140	$1{\cdot}000 \times 10^{7}$	$1{\cdot}000 \times 10^{14}$

Chapter 3

Technical description

This chapter is intended to be read in conjunction with the functional diagram (Fig. 3.1) and the circuit diagram (Fig. 5.1 and Fig. 5.2).

3.1 R.F. OSCILLATOR

A disk-seal triode, V9, connected in a form of shunt-fed Colpitts circuit generates the output frequency. The elements of the tuned circuit are mounted on a turret; there being, for each band, a separate inductor and tuning-capacitor stator-assembly which rotate about the common tuning-capacitor rotor-plates. The appropriate tuned circuit, for the selected band, is connected to the oscillator valve by a pair of coupling capacitors (C51, C52), which are formed by extensions of the tuning-capacitor stator-plates meshing with other plates attached to the frame of the r.f. unit.

The output from the oscillator is fed to a mutual inductance type of piston attenuator. A resistance-capacitance network fitted to the pick-up element of the attenuator maintains a sensibly constant output impedance, irrespective of frequency.

All leads into the r.f. units are filtered to minimize stray radiation; the component values of the filter in the feed to the f.m. modulator valve (V8) being carefully chosen to maintain good a.f. response whilst giving adequate r.f. rejection.

The output level is adjusted by the SET CARRIER control RV2 which varies the oscillator anode voltage.

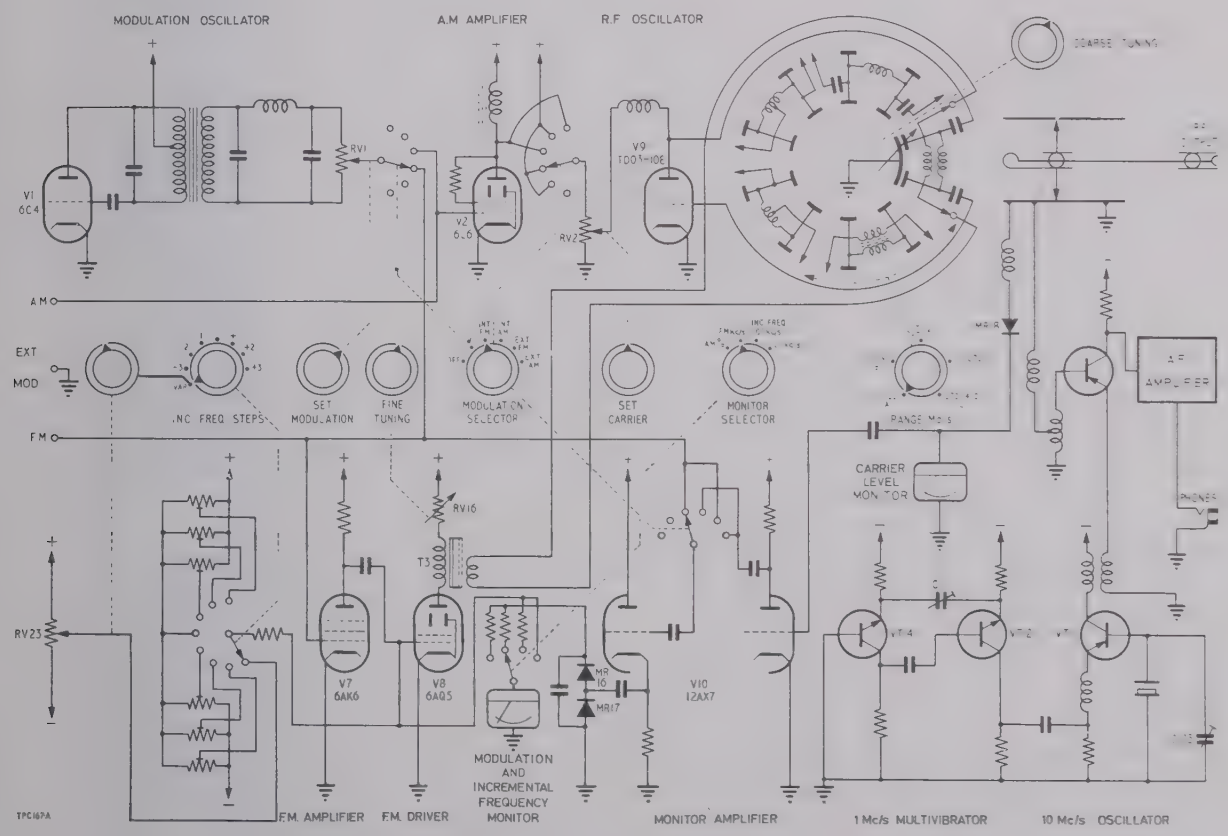


Fig. 3.1 Functional diagram

3.2 MODULATORS

V1 functions as a Hartley oscillator to provide the internal modulating signal. Connected across the oscillator output, the SET. MOD. CONTROL RV1 adjusts the signal level passed to either the a.m. amplifier or the f.m. amplifier.

The a.m. amplifier (V2) operates as an anode modulator; the output being applied to the anode of the r.f. oscillator valve.

Frequency modulation is achieved by means of a ferrite reactor, T3. In this type of modulator the inductance of a small r.f. coil is varied by permeability changes in its ferrite core. This core completes the magnetic circuit of an l.f. inductor whose winding carries the a.f. modulating current. The core is biased to a suitable point on its B/H characteristic by the standing anode current of the driver valve, V8. The ferrite reactor is coupled to the r.f. tuned circuit in use; and thus variations of current through the l.f. winding produce corresponding variations of frequency.

To maintain constant deviation despite changes of frequency, the modulating signal is applied to the f.m. amplifier (V7) via a series of fixed and preset resistors, selected by sections d and e of switch SE (which form part of the range control) and via potentiometer, RV13 (which is ganged to the main tuning control). From the output of the f.m. amplifier, which provides voltage gain, the modulating signal is fed to the driver valve, V8.

3.3 FINE TUNING AND INCREMENTAL FREQUENCY CIRCUITS

The FINE TUNING control, RV16, is connected in series with the anode and screen supply to the driver valve. Changes to the value of this control affect the standing anode current and consequently by the action of the ferrite reactor, cause small changes to the carrier frequency.

Known values of frequency shift are produced by applying d.c. potentials to the driver valve via the f.m. tracking controls. These potentials are derived from the +280 V and -108 V supplies by preset potential dividers, RV17 - RV22, and potentiometer RV23; giving stepped or continuously variable frequency increments respectively.

3.4 MONITORS

The r.f. output is detected by rectifier MR18 and the resulting d.c. component is indicated by the CARRIER LEVEL meter, M1. When the carrier is amplitude modulated there is also an a.f. component which is fed via V10, the individual sections of which function as an R-C coupled amplifier and a cathode follower respectively, to the voltage-doubler rectifier consisting of the diodes MR16, MR17. Thus the MODULATION AND INCREMENTAL FREQUENCY meter M1 indicates the modulation level; the scale being calibrated directly in terms of percentage modulation.

When the instrument is switched to give frequency modulation, the modulating signal is applied direct to the input of the cathode follower section of V10 and hence the meter, M1, indicates the amplitude of the a.f. signal. Because the f.m. tracking network is so adjusted to give deviation proportional to the level of the modulating signal, the meter is scaled directly in terms of frequency deviation.

For monitoring incremental frequency shifts the meter, M1, operates as a simple voltmeter; the deflection being produced by the shift voltage.

3.5 CRYSTAL CALIBRATOR

The calibrator consists of a 10 Mc/s crystal oscillator, VT11, to which is locked a 1 Mc/s multivibrator, VT12 and VT14. The multivibrator, in turn, modulates the 10 Mc/s oscillator at 1 Mc/s intervals.

A coupling coil, L22, within the r.f. box picks up the signal generator carrier frequency which is mixed with the calibrator r.f. output by VT10. Transistors VT14, VT15 and VT16 amplify the resulting audio beat frequency which is passed to the PHONES socket, JK1.

3.6 POWER SUPPLIES

The windings of the mains transformer primary may be interconnected in such ways as to accept input voltages from 100 to 130 V and 200 to 250 V.

The main h.t. supply is derived from two series-connected bridge rectifier circuits via V3 acting as a series stabilizer controlled by V5 and the reference tube V4.

A separate bridge rectifier provides the negative h.t. line, stabilized by V6.

Besides the normal l.t. supplies, a separate stabilized d.c. supply is provided for the heaters of the frequency modulator and r.f. oscillator valves. In this case VT2 acts as a series stabilizer and the reference potential is obtained from a Zener diode, MR15.

Chapter 4

Maintenance

4.1 ACCESS TO COMPONENTS

To remove the case:

(1) Turn the attenuator to maximum output and lay the instrument on its face.

(2) Extract the four screws holding the rear panel and lift it out.

(3) Unscrew the four feet and the two screws between them.

(4) The top and sides and the bottom panel can now be lifted away.

To remove the dust cover of TF 1066B/6:

(1) Turn the attenuator to maximum output and lay the instrument on its face.

(2) Extract the three rear fixing screws.

(3) The dust cover can now be lifted away.

To obtain access to the inside of the r.f. box, besides the bottom and rear cover plates, the top cover carrying the calibrator unit must be removed. Each plate may be freed by slackening the screws around the edges and sliding off the retaining strips.

Care must be taken, when refitting the calibrator unit, to ensure that the wire probe plug into the r.f. box locates in its corresponding socket.

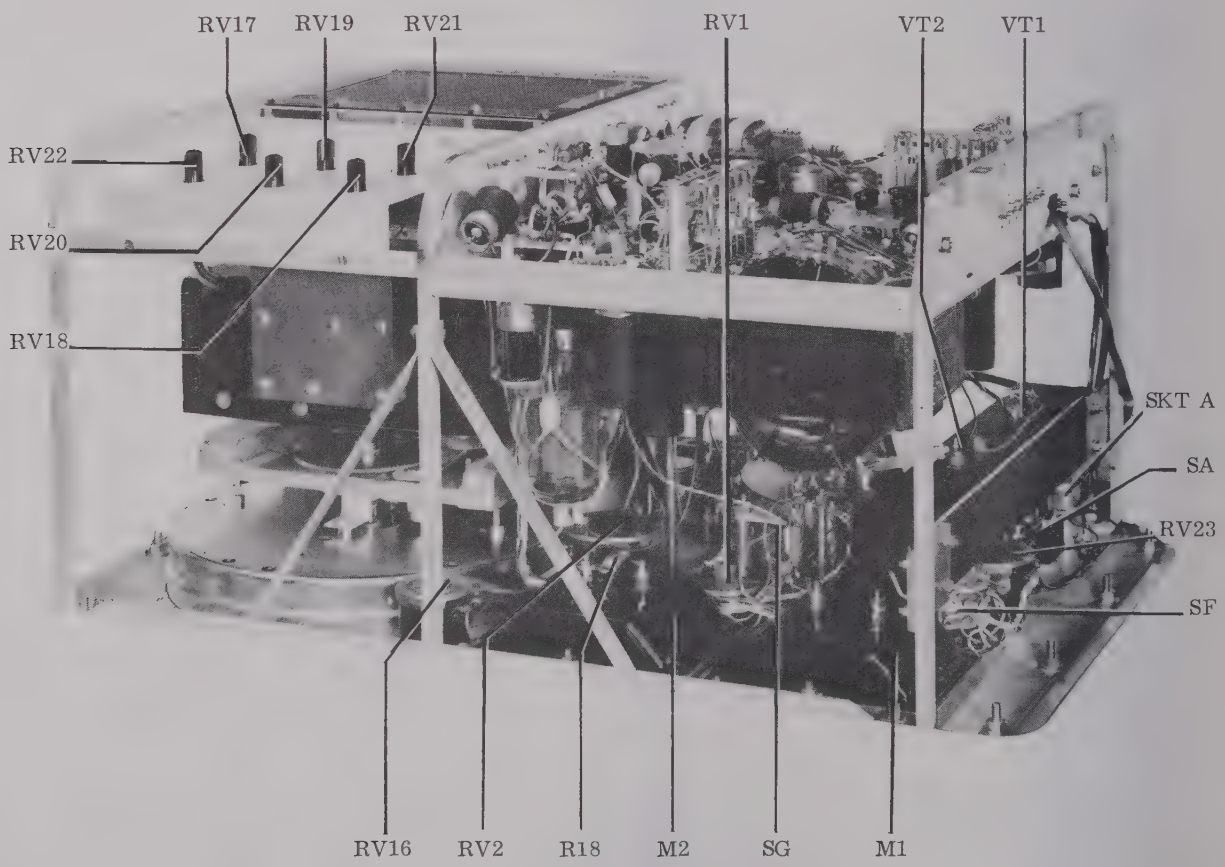


Fig. 4.1 Top view, with case removed

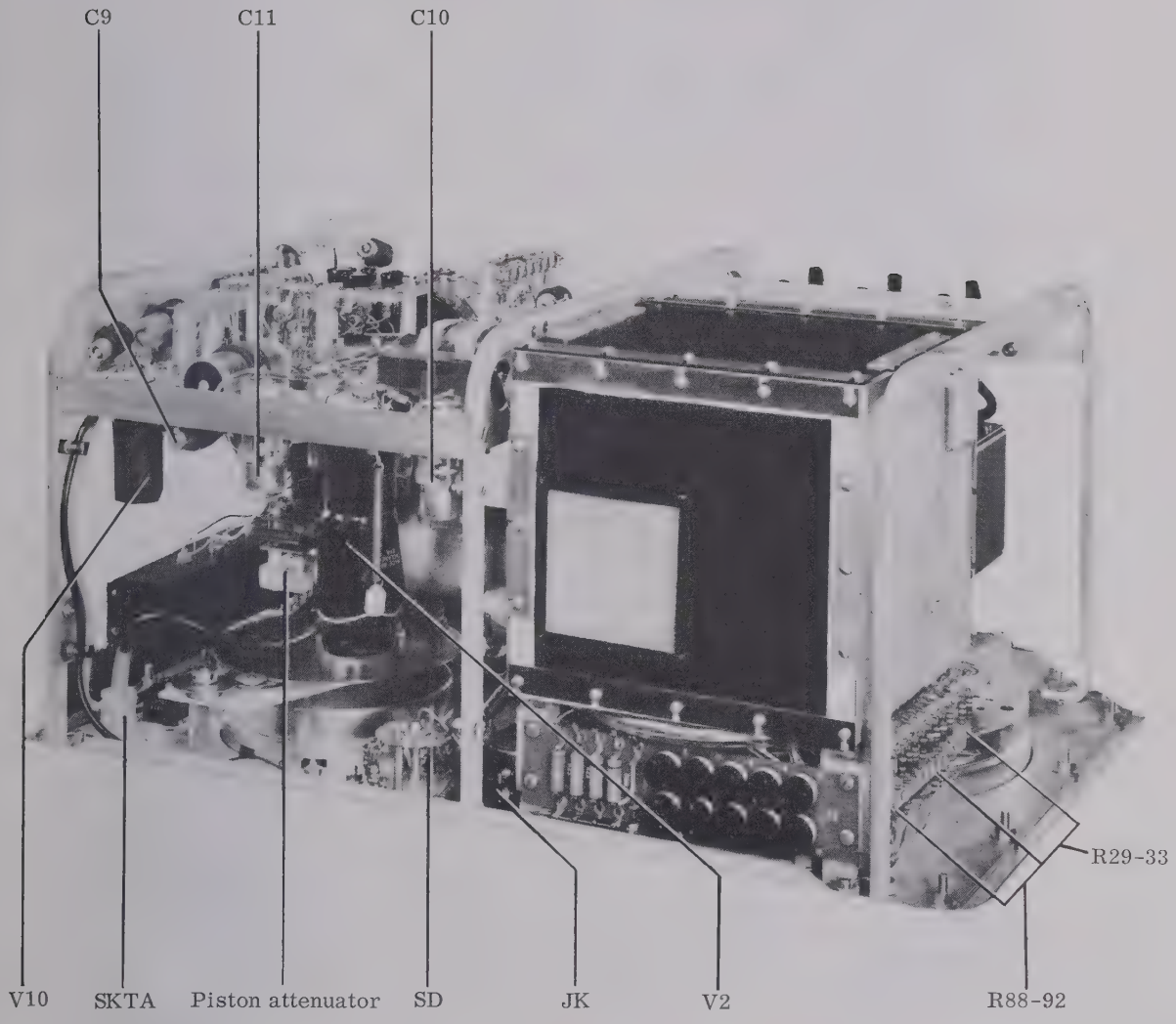


Fig. 4.2 Bottom view, with case removed

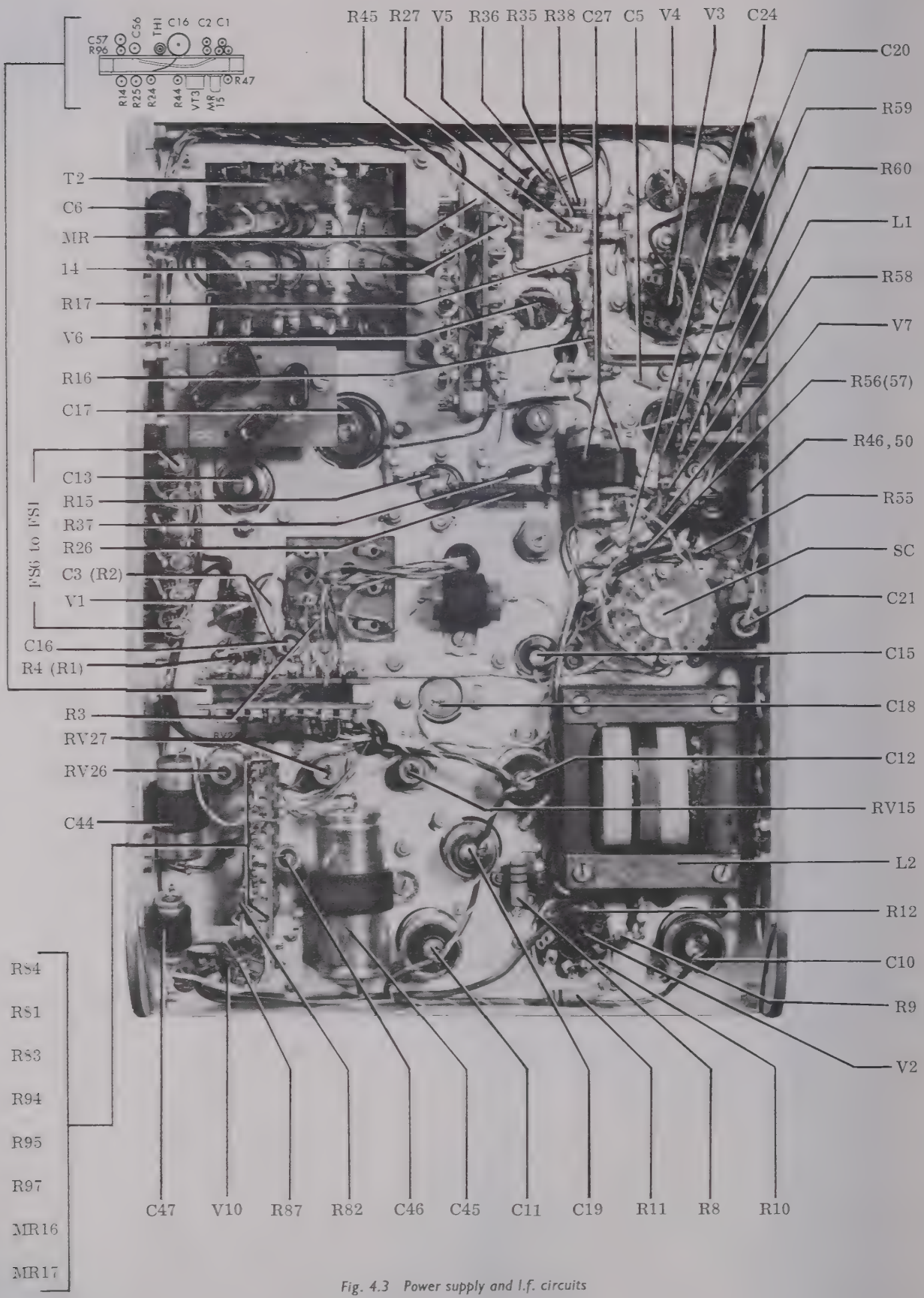


Fig. 4.3 Power supply and l.f. circuits

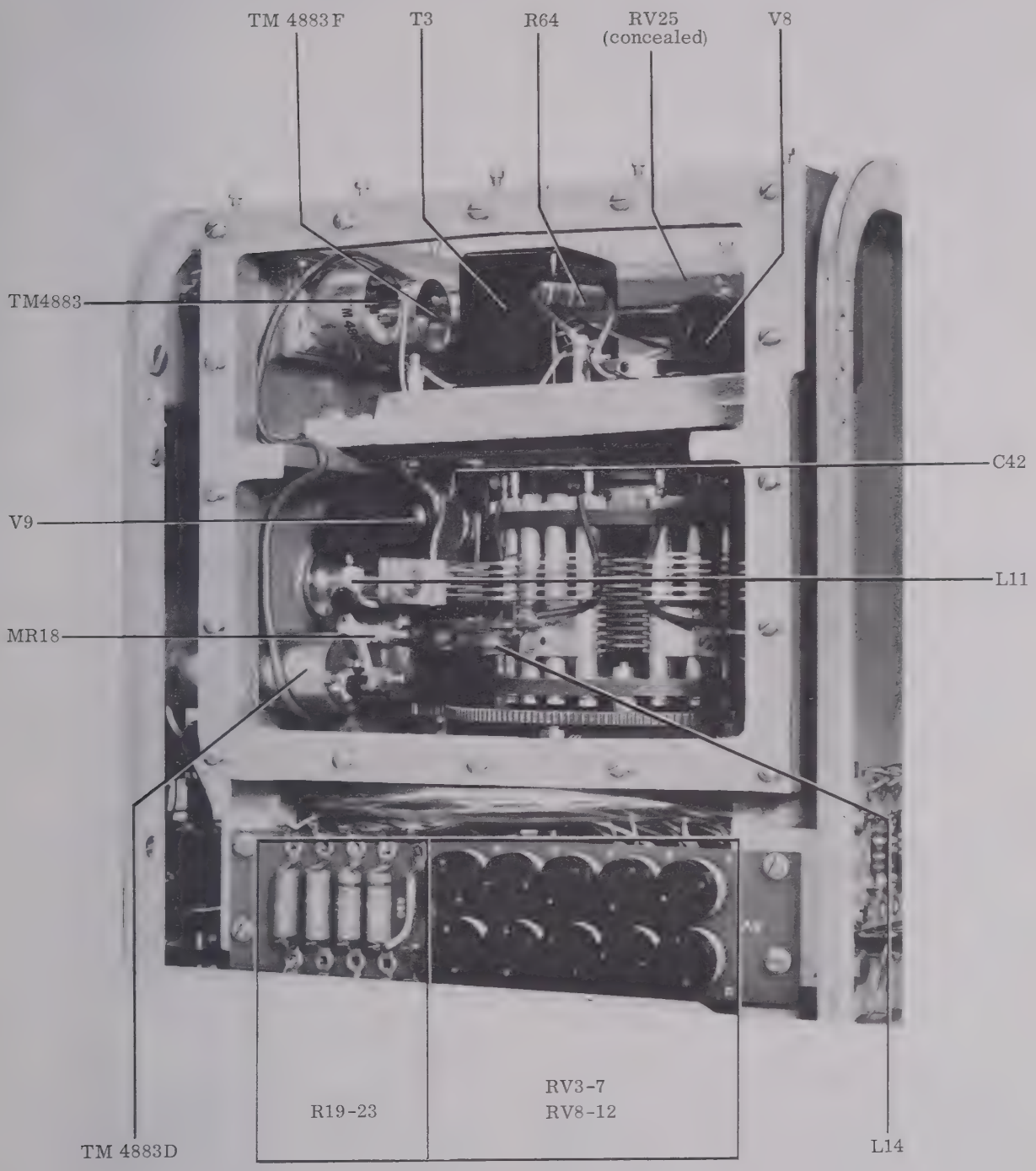


Fig. 4.4 R.F. unit switched to range B, and tracking controls

4.2 CIRCUIT VOLTAGES

The following voltages were taken, using an Avometer model 8, on a typical TF 1066B/6.

Transformer windings - a.c. (r.m.s.) readings with nominal mains input.

HT1	175	V
HT2	175	V
HT3	240	V
LT1	6.3	V
LT2	6.3	V
LT3	14-0-14	V

Valves electrodes - d.c. readings taken with respect to earth.

Table 4.1

Valve	Electrode	Pin no.	Voltage (V)	Conditions
V1 (6C4)	anode	1,5	240	operating
	control grid	6	-37	as 1 kc/s
	cathode	7	7.9	oscillator
V2 (6L6)	anode	3	236	modulation
	screen grid	4	234	selector set
	cathode	8	22.5	to INT. A. M.
V3 (6CD6G)	anode	top cap	460	nominal
	screen grid	8	450	mains
	control grid	5	252	input
	cathode	3	280	
V4 (5651)	anode	1.5	85	nominal
	cathode	2,4,7	0	mains input
V5 (6AK5)	anode	5	252	nominal
	screen grid	6	122	mains
	control grid	1	84	input
	cathode	2,7	85	
V6 (0B2)	anode	1,5	0	nominal
	cathode	2,4,7	-104	mains input
V7 (6AK6)	anode	5	126	modulation
	screen grid	6	162	selector set
	cathode	7	10.5	to INT. F. M.
V8 (6AQ5)	anode	5	260	FINE TUNING
	screen grid	6	260	control at
	cathode	2	24	mid travel

Continued

Table 4.1 continued

Valve	Electrode	Pin no.	Voltage (V)	Conditions
V9 (TD03-10E)	anode	-	50 to 130 depending on frequency	CARRIER LEVEL monitor at SET CARRIER mark
	cathode	-	0	
V10 (12AX7)	anode	1	110	
	cathode	3	6	
	anode	6	280	
	cathode	8	70	

Transistor terminals - d.c. readings measured with respect to earth.

Transistor	Collector voltage (V)	Emitter voltage (V)	Conditions
VT1	-6.7	-0.3	
VT2	-6.7	0	
VT3	-0.4	+1.2	
VT10	+1.2	0	10 Mc/s oscillator operating
VT11	-23.5	-4.6	crystal removed
VT12	-2.0	-3.5	switched to 1 Mc/s
VT13	-5.6	-5.5	
VT14	-0.2	-3.2	switched to 1 Mc/s
VT15	-14.6	-1.8	
VT16	-13.4	-2.3	

Crystal calibrator	pin 9	-24 V
	pin 11	-23.9 V
junction R104/R113		-22.8 V
junction R107/R126		- 5.5 V

4.3 INCREMENTAL FREQUENCY STEPS

The stepped incremental frequency shifts are set up by six preset potentiometers mounted on a panel at the rear of the instrument. Access to these controls is obtained by opening the right-hand hinged door at the rear of the case of the TF 1066B/6 or by removing the dust cover of the TF 1066B/6R.

To set up any particular step turn the INC. FREQ. STEPS switch to the required position and the monitor selector switch to whichever of the INC. FREQ. positions gives the more suitable sensitivity for the desired shift. Adjust the INC. FREQ. STEP pre-set control corresponding to the selected step until the MODULATION AND INCREMENTAL FREQUENCY monitor indicates the required shift.

If the steps are to be used at carrier frequencies in the two highest ranges, due allowance

should be made, when setting up, for the corrections given by the curves on the CORRECTION CHART FOR DEVIATION AND INCREMENTAL FREQUENCY MONITOR.

Remember that before using the frequency shifts which have thus been set up, it will be necessary to neutralize modulator hysteresis using the procedure outlined in Section 2.5 (c).

4.4 ADJUSTMENT OF PRESET CONTROLS

The following simplified adjustment procedures are intended to permit the instrument to be set up following component replacement. If information on adjustments not covered by this manual is required, please write to or telephone our Service Division or Agent. Always mention the type and serial numbers of your instrument. (for address see rear cover).

(a) Set h.t.

Turn the INC. FREQ. STEPS control to the zero position and the monitor selector switch to INC. FREQ. 20 kc/s. Adjust RV14 until the pointer of the MODULATION AND INCREMENTAL FREQUENCY monitor coincides with the centre zero mark of the incremental frequency scales.

(b) Set l.t.

Connect a suitable d.c. voltmeter across the stabilized l.t. line. Adjust RV15 until the meter indicates 6.3 V.

(c) Set f.m.

(i) This adjustment should be checked if V7, V10, MR16 or MR17 have been replaced.

Set up the signal generator for a carrier frequency of about 22 Mc/s (range A), modulating frequency of 1 kc/s and f.m. deviation range of 100 kc/s. Turn the monitor selector switch to F.M. kc/s. Connect a carrier deviation meter, such as mi type TF 791D, to the R.F. OUT SOCKET. Advance the SET MODULATION control until the external deviation meter indicates a deviation of 100 kc/s. Deviation on each side of the carrier should be checked and, if necessary, a compromise adopted. Then adjust RV24 for an indication of 100 kc/s on the MODULATION AND INCREMENTAL FREQUENCY monitor.

(ii) If a replacement for V8 or T3 has been fitted, the following procedure should be adopted. Tune the signal generator to about 22 Mc/s (range A) and switch to the 100 kc/s f.m. deviation range, with a modulating frequency of 1 kc/s. Put the monitor selector switch in the F.M. kc/s position. Turn the SET MODULATION control until a deviation of 100 kc/s is indicated on the MODULATION AND INCREMENTAL FREQUENCY MONITOR. Connect a carrier deviation meter, such as mi type TF 791D, to the R.F. OUT socket and adjust RV12 until the external meter shows a deviation of 100 kc/s. Now retune to about 10 Mc/s and adjust RV7 for an indication of 100 kc/s deviation on the external meter.

Repeat the adjustments to RV12 and RV7, in turn, at the high and low frequency ends of the range respectively, until the best compromise over the whole range is obtained.

The tracking of the other ranges should be corrected in a similar manner. The controls to be adjusted are given in the following table.

Range	Adjust at high frequency end	Adjust at low frequency end
A	RV12	RV7
B	RV11	RV6
C	RV10	RV5
D	RV9	RV4
E	RV8	RV3

The preset controls (RV3 - RV12) associated with these adjustments are grouped together on a panel which is mounted beneath the r.f. box.

(d) Set a.m.

This adjustment should be checked if V10, MR16 or MR17 have been replaced.

Tune the signal generator to about 10 Mc/s (range A) and, with the SET CARRIER control, bring the pointer of the CARRIER LEVEL monitor to the SET CARRIER mark. Turn the modulation selector switch to INT. A.M. and the monitor selector switch to A.M.%. Connect an oscilloscope, such as mi type TF 1330, to the R.F. OUT socket and advance the SET MODULATION control until the modulation depth, as measured on the oscilloscope, is 40%. Percentage modulation is given by the formula:

$$M\,(\%) = \frac{D\,\max - D\,\min}{D\,\max + D\,\min} \times 100$$

where D max is the peak-to-peak and D min the trough-to-trough amplitude of the oscilloscope display.

Finally adjust RV26 until the modulation depth indicated on the MODULATION AND INCREMENTAL FREQUENCY monitor is 40%.

(e) Crystal calibrator

To set the crystal calibrator a standard 10 Mc/s frequency source is required, such as the mi Precision Crystal Calibrator type TF 1374.

Switch on the signal generator and allow to warm up for at least one hour. Tune to 10 Mc/s and connect the R. F. OUT socket to the crystal calibrator. Adjust the signal generator frequency with the COARSE and FINE TUNING controls for zero beat with the 10 Mc/s standard. Disconnect the TF 1374 and turn the range switch of the signal generator calibrator to 10 Mc/s. Connect a pair of high resistance headphones to the PHONES socket and adjust C103 until the internal crystal oscillator gives a zero beat with the signal generator.

Note the dial reading and tune the signal generator until the next 10 Mc/s marker is heard. Turn the crystal calibrator range switch to 1 Mc/s and slowly retune the signal generator to its original position counting the number of intermediate marker pips between the 10 Mc/s and 20 Mc/s positions. If additional 0.5 Mc/s markers are heard, they should be disregarded. These sub-harmonic beats may readily be identified by their much lower amplitude.

When correctly set up there are nine intermediate markers corresponding to ten 1 Mc/s intervals. If fewer than nine intermediate markers are heard adjust C111 to increase its capacity. If there are more than nine markers, the capacity of C111 must be reduced.

The preset capacitors C103 and C111 are accessible through holes at the rear of the calibrator unit. These holes are normally covered by press studs.

4.5 FUSES

Six fuses are fitted to protect the power supply circuits. They are all mounted on a panel to which access may be obtained by opening the left-hand hinged door at the rear of the case of the TF 1066B/6 or by removing the dust cover of the TF 1066B/6R.

The fuse ratings are given in the following table

FS1	2A
FS2	2A
FS3	2A
FS4	2A
FS5	250 mA
FS6	100 mA

Chapter 6

Replaceable parts

Introduction

This chapter lists replaceable parts in alpha-numerical order of their circuit references. The following abbreviations and symbols are used:-

Note : Carbon resistors have been changed to metal film type - tolerance ±2%, rating $\frac{1}{4}$ W at 70°C also metal oxide type resistors are re-rated - tolerance ±2%, $\frac{1}{4}$ W at 70°C.

C : capacitor
Carb : carbon
Cer : ceramic
Elec : electrolytic
FS : fuse
JK : jack
L : inductor
M : meter
Met : metal
Min : minimum value
MR : semiconductor diode
NNF : not normally fitted
Ox : oxide
PL : plug
PLP : pilot lamp
Plas : plastic
R : resistor
RV : variable resistor
S : switch
SKT : socket
T : transformer
TE : total excursion
TH : thermistor
V : valve
Var : variable
VT : transistor
W : watts at 70°C
W* : watts at 55°C
WW : wire wound
XL : crystal
† : value selected during test; nominal value listed
Ø : feed through component

Ordering

Send your order for replacement parts to our Service Division at the address given on the back cover. Specify the following information for each part required.

1) Type and serial number of instrument
2) Circuit reference
3) Description
4) M.I. code number

Circuit reference	Description	M.I. code
C1†	Paper 0.015µF 400V	26174-148
C2†	Paper 500pF 350V	26112-419
C3	Paper 0.01µF 20% 400V	26174-148
C5	Paper 0.005µF 20% 250V	26174-142
C6	Paper 0.1µF 20% 150V	26155-563
C7	Paper 0.1µF 20% 350V	26174-174
C8	Plas 1µF 20% 150V	26512-280
C9	Elec 25µF +100-20% 25V	26417-143
C10	Elec 1000µF +50-20% 25V	26417-406
C11	Elec 1000µF +50-20% 25V	26417-406
C12	Elec 1000µF +50-20% 25V	26417-406
C13	Elec 8µF +50-20% 500V	26415-325
C14	Elec 8µF +50-20% 450V	26417-477
C15	Elec 8µF +50-20% 450V	26417-477
C16	Paper 0.1µF 20% 150V	26155-563
C17	Elec 32µF +50-20% 500V	26425-120
C18	Elec 8µF +50-20% 450V	26417-477
C19	Elec 500µF +100-20% 25V	26417-228
C20	Paper 0.25µF 20% 350V	26155-574
C21	Paper 0.1µF 20% 150V	26155-563
C22	Elec 8µF +50-20% 450V	26417-477
C23	Elec 25µF +100-20% 25V	26417-143
C24	Paper 0.02µF 20% 200V	26174-152
C25	Elec 25µF +100-20% 50V	26415-131
C26	Paper 1µF 20% 250V	26155-579
C27	Paper 0.1µF 20% 350V	26174-174
C28	Cer Ø 200pF min.	26332-114
C29	Cer Ø 200pF min.	26332-114
C30	Cer Ø 200pF min.	26332-114
C31	Cer Ø 4700pF min.	26372-615
C32	Cer Ø 4700pF min.	26372-615
C33	Cer Ø 4700pF min.	26372-615
C34	Cer Ø 50pF min.	26372-604
C35	Cer Ø 50pF min.	26372-604

Circuit reference	Description	M.I. code
C36	Cer ∅ 50pF min.	26372-604
C37	Paper 0.005μF 20% 250V	26174-142
C38 †	Cer 100pF 2% 750V	26324-897
C39	Cer ∅ 4700pF min.	26372-615
C40	Cer ∅ 4700pF min.	26372-615
C41	Cer ∅ 4700pF min.	26372-615
C42	Cer 1pF ±0.5pF 500V	26321-007
C43	Var Plas 0.5pF - 3pF	26872-104
C44	Elec 8μF +50-20% 450V	26417-477
C45	Paper 6μF 20% 150V	26165-125
C46	Paper 0.05μF 20% 250V	26155-557
C47	Paper 0.05μF 20% 250V	26155-557
C48	Cer 2.2pF ±5pF 750V	26324-042
C49	50pF COARSE TUNING, special	7/8-TM6242/2
C50	Cer 2.2pF ±5pF 750V	26324-042
C51	27pF special	23-TM6241/5
C52	27pF special	23-TM6241/5
C53	Cer ∅ 500pF min.	26372-609
C54	Cer ∅ 500pF min.	26372-609
C55	Cer ∅ 500pF min.	26372-609
C56	Paper 0.002μF 20% 350V	26174-130
C57	Paper 0.005μF 20% 250V	26174-142
C58	Cer 47pF 10% 500V	26338-317
C59	200pF special part of	TM6312/1
C60	Paper 0.25μF 20% 350V	26155-574
C61	Cer 33pF 5% 750V	26324-822
C62	Elec 10μF +100-20% 70V	26417-128
C63	Cer 0.1μF +50-25% 30V	26383-031
C100	Cer 0.001μF +80-20% 500V	26383-242
C101	Cer 0.001μF +80-20% 500V	26383-242
C102	Plas 220pF 5% 125V	26516-328
C103	Var Cer 10-45pF	26847-462
C104	Cer 0.01μF +80-20% 500V	26383-392
C105	Cer 0.01μF +80-20% 500V	26383-392
C106	Cer 0.001μF +80-20% 500V	26383-242
C107	Cer 33pF 5% 750V	26324-822
C108	Elec 8μF +100-20% 25V	26412-236
C109	Elec 10μF +100-20% 6V	26414-120
C110	Elec 100μF +100-20% 6V	26417-154
C111	Var Cer 10-45pF	26847-462
C112	Mica 220pF 5% 350V	26272-073
C113	Cer 0.01μF +80-20% 500V	26383-392
C114	Elec 10μF +100-20% 6V	26414-120
C115	Elec 100μF +100-20% 25V	26417-158
C116	Elec 100μF +100-20% 25V	26417-158
C117	Elec 8μF +100-20% 25V	26412-236
C118	Elec 100μF +100-20% 6V	26417-154
C119	Cer 0.01μF +80-20% 500V	26383-392
C120	Paper 0.1μF 10% 150V	26174-169
C121	Elec 5μF +100-20% 50V	26414-114
C122	Elec 100μF +100-20% 5V	26417-154
C123	Elec 100μF +100-20% 25V	26417-158
C124	Cer ∅ 4700pF min.	26372-615
C125	Cer ∅ 4700pF min.	26372-615
C126	Cer ∅ 4700pF min.	26372-615
C127	Cer ∅ 4700pF min.	26372-615
C128	Cer ∅ 4700pF min.	26372-615
C129	Cer ∅ 4700pF min.	26372-615
C132	Cer ∅ 4700pF min.	26372-615
C133	Cer ∅ 4700pF min.	26372-615
C134	Cer 0.01μF +80-20% 500V	26383-392
C135 †	22pF ±0.25pF 750V	26324-715
FS1	2A Quick acting	23411-260
FS2	2A Quick acting	23411-260
FS3	2A Quick acting	23411-260
FS4	2A Quick acting	23411-260
FS5	250mA Quick acting	23411-255
FS6	100mA Quick acting	23411-253
JK1	Panel jack	23421-681
L1	Filter coil 250mH	44271-205
L2	Modulation choke 27H	44218-001
L3	Filter coil 95μH	44264-603
L4	Filter coil 95μH	44264-603
L5	Filter coil 95μH	44264-603

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
L6	Filter coil 95μH	44264-603
L7	Filter coil 95μH	44264-603
L8	Filter coil 95μH	44264-603
L9	Filter coil 6μH	44414-079
L10	Filter coil 6μH	44414-079
L11	R.F. choke	44155-808
L12	Bifilar choke	44262-601
L13	OSC. coil range D	44111-413
L14	OSC. coil range C	44222-201
L15	OSC. coil range E	44111-406
L16	OSC. coil range B	44228-012
L17	OSC. coil range A	44244-202
L18	Atten. coil	35128-101
L19	Monitor coil	43143-008
L20	Filter coil 95μH	44264-605
L21	Filter coil 95μH	44264-605
L22	Calibrator pick up loop	26-TM6241/5
L23	Filter coil	44286-206
L25	Calibrator input coil	TB39318
L27	R.F. choke 10.4μH	TB23173/123
L28	R.F. choke 4.1μH	TB39319/TB24630/2
L29	R.F. choke	TB45251
L30	Filter coil	TB45251
L31	Filter coil	TB45251
L32	Filter coil	TB45251
L34	Filter coil	TB45251
MR1	1N4003	28356-096
MR2	1N4003	28356-096
MR3	1N540	28357-748
MR4	1N540	28357-048
MR5	1N540	28357-048
MR6	1N540	28357-048
MR7	1N540	28357-048
MR8	1N540	28357-048
MR9	1N540	28357-048
MR10	1N540	28357-048
MR11	1N540	28357-048
MR12	1N540	28357-048
MR13	1N540	28357-048
MR14	1N540	28357-048
MR15	4.7V 10%	28371-376
MR16	CG1E (CV 425)	28323-021
MR17	CG1E (CV 425)	28323-021
MR18	CS2A	28346-121
MR19	1S44	28357-548
MR20	HG1005	28323-035
M1	500Ω 100μA f.s.d.	44554-421
M2	500Ω 100μA f.s.d.	44554-403
PLA	3 pin 5A	23423-152
PLB	Part of assembly	-
PLC	7 way	23435-007
PLP1	6.3V 0.15A	23735-433
R1	Met ox 2.2kΩ 2% ¼W	24511-588
R2	Met ox 47kΩ 2% ¼W	24511-626
R3	Met ox 2.2kΩ 2% ¼W	24511-588
R4	Met ox 220kΩ 2% ¼W	24511-643
R5	Met ox 18kΩ 2% ½W	24573-103
R6	Met ox 82kΩ 2% ¼W	24573-119
R7	†Met ox 100kΩ 2% ½W	24573-121
R8	Met ox 10Ω 2% ½W	24573-025
R9	Met ox 560kΩ 2% ½W	24573-139
R10	Met ox 270kΩ 2% ¼W	24511-646
R11	Met ox 1kΩ 2% ½W	24573-073
R12	Met ox 100Ω 2% ¼W	24511-550
R13	WW 2.2kΩ 5% 3W	25125-088
R14	WW 1Ω 10% 1½W	25133-001
R15	Met ox 22Ω 2% ¼W	24511-528
R16	Met ox 22Ω 2% ¼W	24511-528
R17	WW 1kΩ 5% 1½W	25123-080
R18	Met ox 10kΩ 5% 1W	24585-150
R19	† N.N.F.	-
R20	† N.N.F.	-

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R21	† Met ox 10kΩ 2% ¼W	24573-097
R22	† Met ox 10kΩ 2% ¼W	24573-097
R23	† N.N.F.	24573-097
R24	Met ox 1kΩ 2% ¼W	24511-580
R25	WW 1.5Ω 10% 1½W	25133-003
R26	WW 4.7kΩ 5% 4½W	25126-600
R27	Met ox 330kΩ 2% ¼W	24511-563
R28	WW 15kΩ 5% 4½W	25126-614
R29	† Met ox 18kΩ 2% ¼W	24511-616
R30	† Met ox 33kΩ 2% ¼W	24511-622
R31	† Met ox 18kΩ 2% ¼W	24511-616
R32	† Met ox 56kΩ 2% ¼W	24511-629
R33	N.N.F.	-
R34	Met ox 100Ω 2% ¼W	24511-550
R35	Met ox 680kΩ 2% ¼W	24573-141
R36	Met ox 47kΩ 2% ¼W	24511-626
R37	WW 1.5kΩ 5% 1½W	25123-084
R38	Met ox 4.7kΩ 2% ¼W	24511-600
R39	Met ox 10kΩ 2% ¼W	24573-097
R40	Met ox 4.7kΩ 2% ¼W	24511-600
R41	Met ox 10kΩ 2% ¼W	24511-610
R42	Met ox 22kΩ 2% ¼W	24511-618
R43	Met ox 22kΩ 2% ¼W	24511-618
R44	Met ox 18kΩ 2% ¼W	24511-616
R45	Met ox 100kΩ 2% ½W	24573-121
R46	Met ox 22kΩ 2% ½W	24573-105
R47	Met ox 68Ω 2% ¼W	24511-543
R48	Met ox 100kΩ 2% ¼W	24511-635
R49	Met ox 33kΩ 2% ¼W	24511-622
R50	Met ox 22kΩ 2% ¼W	24511-631
R51	Met ox 1MΩ 2% ¼W	24511-641
R52	Met ox 820Ω 2% ½W	24573-071
R53	Met ox 100Ω 2% ½W	24573-049
R54	Met ox 1MΩ 2% ½W	24573-145
R55	Met ox 47kΩ 2% ½W	24573-113
R56	Met ox 1MΩ 2% ½W	24573-145
R57	Met ox 270kΩ 2% ½W	24573-131
R58	Met ox 1kΩ 2% ½W	24573-073
R59	Met ox 18kΩ 5% 2W	24587-256
R60	Met ox 68kΩ 2% ¼W	24511-631
R61	Met ox 2-43kΩ 2% ½W in parallel	24593-112
R62	Met ox 27kΩ 2% ½W	24573-107
R63	Met ox 27kΩ 2% ½W	24573-107
R64	† Met ox 47kΩ 2% ½W	24573-113
R65	Met ox 1kΩ 2% ¼W	24511-580
R66	Met ox 10kΩ 2% ½W	24573-097
R67	Met ox 10kΩ 2% ½W	24573-097
R68	Met ox 56kΩ 2% ½W	24573-115
R69	Met ox 1kΩ 2% ½W	24573-073
R70	Met ox 150Ω 2% ¼W	24511-554
R71	† Met ox 390kΩ 2% ½W	24573-135
R72	Carb 120kΩ 2% ¼W	24136-120
R73	† Met ox 100kΩ 2% ¼W	24511-635
R74	Met ox 47kΩ 2% ½W	24573-113
R75	† Met ox 15kΩ 2% ¼W	24511-614
R76	Met ox 330Ω 2% ¼W	24511-563
R77	Carb 5.6MΩ 2% 3/4W	24177-560
R78	Carb 480kΩ 2% ¼W	24136-480
R79	Met ox 10kΩ 2% ¼W	24511-610
R80	Carb 70MΩ 20% 1/8W	24288-456
R81	Met ox 1MΩ 2% ½W	24573-146
R82	Met ox 4.7kΩ 2% ¼W	24511-600
R83	Met ox 470Ω 2% ¼W	24511-569
R84	Met ox 33kΩ 2% ½W	24573-109
R85	Met ox 47Ω 2% ¼W	24511-537
R86	Met ox 100Ω 2% ¼W	24511-550
R87	Met ox 180kΩ 2% ¼W	24511-641
R88	† Met ox 1kΩ 2% ¼W	24511-580
R89	† Met ox 820Ω 2% ¼W	24511-578
R90	† Met ox 1.8kΩ 2% ¼W	24511-586
R91	† Met ox 2.7kΩ 2% ¼W	24511-592
R92	† Met ox 1.8kΩ 2% ¼W	24511-586
R93	Met ox 47Ω 2% ¼W	24511-537
R94	Met ox 4.7kΩ 2% ¼W	24511-600
R95	Met ox 1MΩ 2% ½W	24573-146
R96	Met ox 2.2kΩ 2% ¼W	24511-588
R97	Met ox 1.2kΩ 2% ¼W	24511-582

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R98	Met ox 680Ω 2% ¼W	24511-576
R99	WW 39Ω 5% 1½W	25123-035
R100	Met ox 100kΩ 2% ¼W	24511-635
R101	Met ox 15kΩ 2% ¼W	24511-614
R102	Met ox 5.6kΩ 2% ¼W	24511-603
R103	† Carb 6.8kΩ 10% 1/10W	24341-306
R104	Met ox 100kΩ 2% ¼W	24511-635
R105	Met ox 100kΩ 2% ¼W	24511-635
R106	† Met ox 33kΩ 2% ¼W	24573-109
R107	Met ox 1kΩ 2% ¼W	24511-580
R108	Met ox 470Ω 2% ¼W	24511-569
R109	Met ox 33kΩ 2% ¼W	24511-622
R110	Met ox 10kΩ 2% ¼W	24511-610
R111	Met ox 3.3kΩ 2% ¼W	24511-594
R112	Met ox 3.3kΩ 2% ¼W	24511-594
R113	Met ox 1kΩ 2% ¼W	24511-580
R114	Met ox 220kΩ 2% ¼W	24511-643
R115	Met ox 22kΩ 2% ¼W	24511-618
R116	Met ox 10kΩ 2% ¼W	24511-610
R117	Met ox 1kΩ 2% ¼W	24511-580
R118	Met ox 22kΩ 2% ¼W	24511-618
R119	Met ox 4.7kΩ 2% ¼W	24511-600
R120	Met ox 3.3kΩ 2% ¼W	24511-594
R121	Met ox 3.3kΩ 2% ¼W	24511-594
R122	Met ox 68kΩ 2% ¼W	24511-631
R123	Met ox 8.2kΩ 2% ¼W	24511-608
R124	Met ox 10kΩ 2% ¼W	24511-610
R125	Met ox 2.2kΩ 2% ¼W	24511-588
R126	Met ox 4.7kΩ 2% ¼W	24511-600
R127	Met ox 100kΩ 2% ¼W	24511-635
R128	† Met ox 22kΩ 2% ¼W	24511-618
R129	Met ox 22kΩ 2% ¼W	24511-618
R130	Met ox 680Ω 2% ½W	24573-141
R131	† Met ox 47kΩ 2% ¼W	24511-626
R132	Met ox 8.2kΩ 2% ½W	24573-095
RV1	WW 10kΩ 10% 1W	25853-181
RV2	WW 22kΩ 10% 7½W	25832-128
RV3	Carb 10kΩ 20% ¼W	25611-126
RV4	Carb 22kΩ 20% ¼W	25611-130
RV5	Carb 47kΩ 20% ¼W	25611-134
RV6	Carb 10kΩ 20% ¼W	25611-126
RV7	Carb 15kΩ 20% ¼W	25611-128
RV8	Carb 10kΩ 20% ¼W	25611-126
RV9	Carb 10kΩ 20% ¼W	25611-126
RV10	Carb 10kΩ 20% ¼W	25611-126
RV11	Carb 10kΩ 20% ¼W	25611-126
RV12	Carb 10kΩ 20% ¼W	25611-126
RV13	WW 5kΩ 10% 3W	25853-513
RV14	WW 50kΩ 10% 1W	25815-383
RV15	WW 250Ω 10% 1W	25815-174
RV16	WW 5kΩ 10% 2W	25816-248
RV17	Carb 25kΩ 20% 1W	25641-118
RV18	Carb 25kΩ 20% 1W	25641-118
RV19	Carb 25kΩ 20% 1W	25641-118
RV20	Carb 25kΩ 20% 1W	25641-118
RV21	Carb 25kΩ 20% 1W	25641-118
RV22	Carb 25kΩ 20% 1W	25641-118
RV23	WW 50kΩ 10% 1W	25814-386
RV24	WW 15kΩ 10% 1W	25815-360
RV25	WW 1kΩ 10% ½W	25813-313
RV26	WW 10kΩ 10% 1W	25815-353
RV27	WW 5kΩ 10% 1W	25815-184
RV28	Carb 2kΩ 20% ¼W	25653-205
RV29	Carb 47kΩ 20% ¼W	25611-034
SA	Mains	44334-003
SB	Mod frequency	44321-118
SC	Modulation selector	44324-809
SD	F.M. range	44322-409
SE	Range	44324-406
SF	Inc. freq. steps	44325-506
SG	Monitor selector	44323-306
SH	Calibrator range	44322-122

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
SKTA	50Ω Coaxial	23443-773
SKTB	Part of assembly	-
SKTC	7 way	23435-037
TH1	Brimistor CZ3	25683-644
T1	Modulation	43525-002
T2	Mains	43467-010
T3	Reactor	167-TM6241/5
V1	6C4	28122-402
V2	6L6	28143-576
V3	6CD6G	28143-592
V4	5651	28216-234
V5	6AK5	28152-482
V6	0B2	28213-292
V7	6AK6	28152-232
V8	6AQ5	28142-502
V9	TD03-10E	28128-208
V10	12AX7	28124-302
VT1	0C25	28424-807
VT2	2N1553	28424-886
VT3	ACY20	28424-747
VT10	AF239	28422-121
VT11	2N1748A	28423-617
VT12	2S102	28455-378
VT13	ACY20	28424-747
VT14	2S102	28455-378
VT15	ACY20	28424-747
VT16	ACY20	28424-747
XL1	10Mc/s Q0 1760B 50/A/30	28311-770

For symbols and abbreviations see introduction to this chapter

Chapter 7

Circuit diagrams

Circuit notes

1. COMPONENT VALUES

Resistors: No suffix = ohms, k = kilohms, M = megohms.
Capacitors: No suffix = microfarads, p = picofarads.
S.I.C.: value selected during test, nominal value shown.

2. SYMBOLS

arrow indicates the sense of movement corresponding to clockwise rotation of knob.

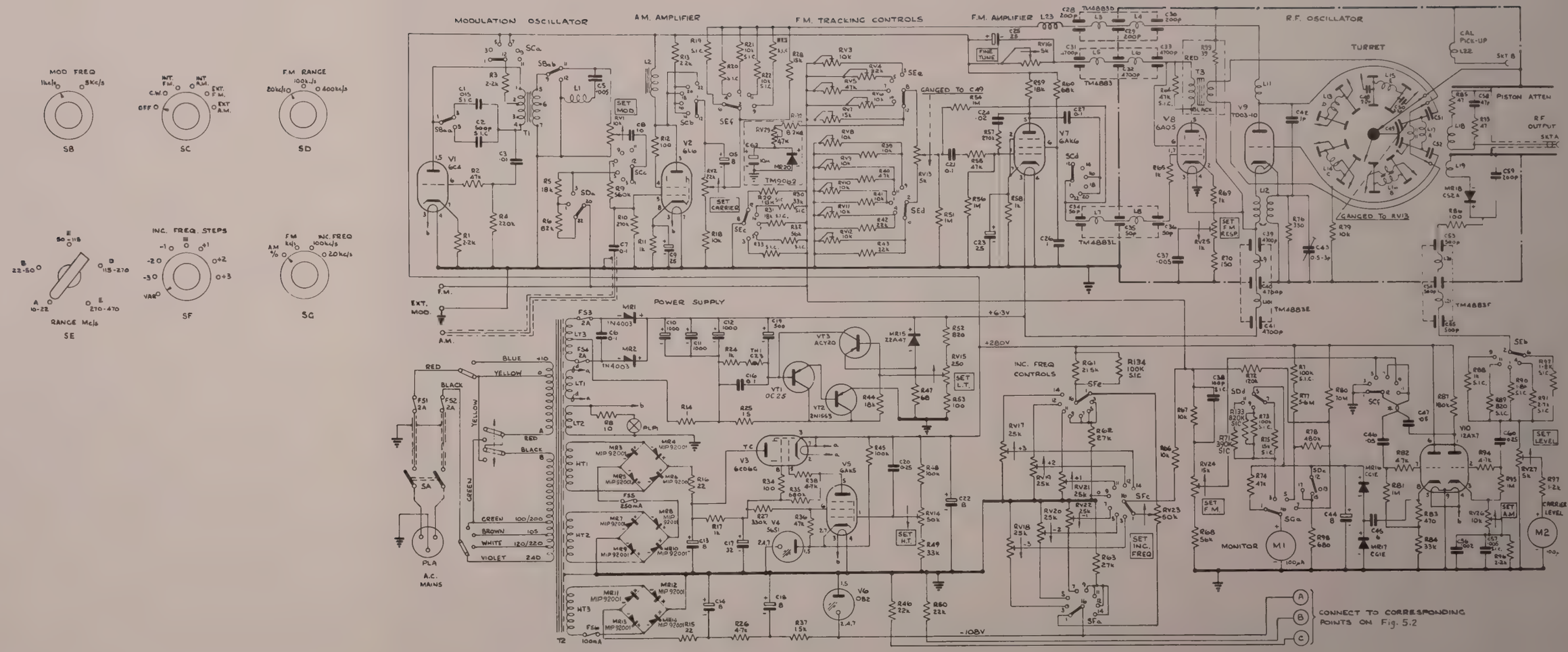


Fig. 7.1 Circuit diagram; r.f. oscillator, i.f. circuits and power supply

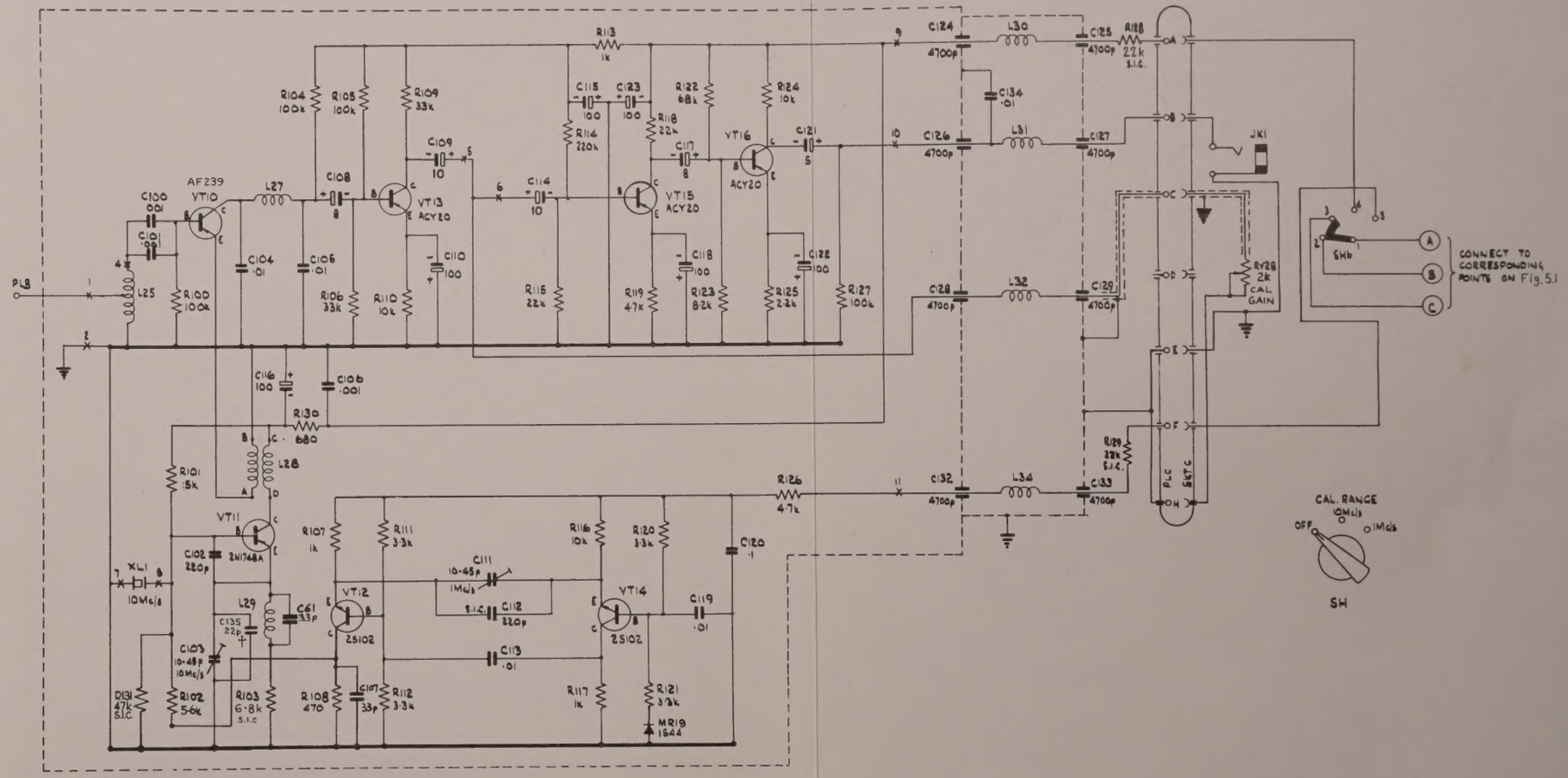


Fig. 7.2 Circuit diagram; crystal calibrator

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MARCONI INSTRUMENTS LIMITED

SERVICE DIVISION

THE AIRPORT, LUTON,
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U.S.A.

MARCONI INSTRUMENTS
100 Stonehurst Court
Northvale, N.J. 07647

BUNDESREPUBLIK DEUTSCHLAND

MARCONI MESSTECHNIK G.m.b.H.,
P.O. BOX NO. 210330
JOERGSTRASSE 74
8 MUNICH 21

Telephones : 58.32.97; 58.42.05; 58.61.56
Telex : 0524642

FRANCE

MARCONI INSTRUMENTS,
SUCCURSALE DE FRANCE,
32 AVENUE DES ECOLES,
91600 SAVIGNY SUR ORGE

Telephone : 921.93.86
Telex : 60541

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